



Affordable Housing Meets Rooftop Farming

Feeding Los Angeles' Low Income Residents

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May 2017

Abstract

The following report seeks to answer the question, how can rooftop farming on affordable housing developments be implemented as an attainable option for increasing access to affordable local produce in the city of Los Angeles, CA? Research of existing literature found that the key challenges and barriers to implementing rooftop farms is the additional cost as well as the lack of information available to guide the development of such projects. Further, the literature also uncovered the environmental services, social, health, and mental health benefits, as well as financial incentives to developers that rooftop gardens can provide. Through interviews with affordable housing developers in Los Angeles, CA it was found that their top concerns regarding the implementation of rooftop farms were the associated cost, maintenance, and safety measures it would require. Additionally, apprehensiveness about levels of resident participation was common to nearly all of the developers interviewed. In order to tackle the concerns of developers, recommendations were made to design urban gardens as a multi-use spaces, partner with urban agriculture organizations to relieve developers of some of the planning burden, and lastly frame urban gardens as health and wellness focused to cater to current sources of funding available in Los Angeles, California.

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Introduction

The city of Los Angeles is known for homelessness and housing inequality, as Los Angeles has the highest rate of homelessness and lowest rate of housing vacancy in the country (Romero, 2008). However, a lesser understood issue facing many residents of Los Angeles is unequal food access. Food insecurity affects more than half a million people in Los Angeles each year (USDA, 2015). It is clear, there is a need for both more affordable housing options and efforts to increase food access. To make healthy food more accessible there must be a shift in focus to develop a local food economy. Creating a local food economy helps to control costs for both the farmer and consumer, as well as increase the sustainability of the food system as a whole (Feenstra, 2009). However, with an extremely low vacancy rate and difficulty of acquiring land for both housing and urban agriculture (Henrickson, 2012), how could valuable space be best utilized? One option is to transform rooftop spaces into lush food production centers. The rooftop farm and affordable housing development can form a symbiotic relationship to equally benefit each other. The affordable housing development will provide the space for a rooftop farm, as well as residents to help maintain and cultivate the farm for their benefit. Simultaneously, the rooftop farm will produce fresh, nutritious produce to feed residents of the building as well as local community members.

Creating a direct link between food access and housing supports the comprehensive needs of residents of Los Angeles, while efficiently using land and funding. Both housing and food access have implications far more comprehensive than simply providing food and shelter. Studies show low quality housing and food insecurity lead to poor school performance in children, as well as health effects like obesity, asthma, and type II diabetes (Jyoti *et al.*, 2005). By providing a dignified place to live and nutritious foods to support residents and community members, the physical and mental health impacts will improve residents' quality of life far

beyond the walls of their apartment (Bellows et al., 2005). Beyond the individual benefits, rooftop farms provide financial incentives to affordable housing developers by insulating the housing units below, effectively saving the building heating and cooling costs, as well as reducing energy consumption (GRHC, 2007). Also rooftop farms provide ecosystem services like urban heat island mitigation, storm water attenuation, and air purification, that benefit not only the residents and community, but the overall environmental quality of the city of Los Angeles. The following paper will delve more into the benefits and challenges of rooftop gardening to understand how they can be feasibly implemented on affordable housing developments to increase access to fresh produce to low income residents of Los Angeles.

Literature Review

Informing subsequent primary research to discover the ways in which rooftop farming can be a feasible option for affordable housing developments to increase access to fresh produce in Los Angeles, CA, a thorough review of the literature of rooftop farming and gardening was conducted. The key points determined from the literature are the primary identifiers, challenges, and benefits of greenroofs and using them for farming or gardening. The literature revealed the comprehensive benefits of green roofs and rooftop farms such as their contribution to building sustainability (USGBC, 2016) (GSA, 2007), positive mental and physical health outcomes (Bellows et al. 2016) (Surls et al. 2016), and their role as an urban habitat sanctuary (Latty, 2016). On the other hand, green roofs and rooftop farming face several challenges or barriers to their development such as financing (LA EAD, 2007) and lack of information (Surls et al., 2016). Figure 1 below summarizes the benefits and challenges of green roofs and rooftop gardens that will be expanded upon in the following sections.

Figure 1.	
Benefits: Environmental <ul style="list-style-type: none"> - Urban heat island effect mitigation - Stormwater drainage - Air purification - Increased urban habitat Development <ul style="list-style-type: none"> - Extends rooflife - Corporate Social Responsibility - Reduced Heating and Cooling costs Health and Social <ul style="list-style-type: none"> - Stress reduction and increased productivity - Community empowerment and ownership of environment - Reduced food expenses for residents 	Challenges: <ul style="list-style-type: none"> - Expensive upfront costs - Continued maintenance- labor and costs - Lack of information to start development
Opportunities: <ul style="list-style-type: none"> - Educational programs - Volunteer & Job training 	Threats: <ul style="list-style-type: none"> - Crops contaminated by urban pollution - Drought & water use

What are Green Roofs?

A green roof is an adapted roof that uses multiple layers of waterproof membranes, drainage, soil or growing medium, and some form of vegetation. They were first developed in France during the 1920s alongside the advent of the Le Corbusier flat roof design as part of his five principles of modern architecture (GSA, 2007). Additionally, green roofs can be divided into vegetation units and include pathways and gathering space among other elements, but the four main elements are a drainage layer, waterproof membranes, growing medium and vegetation (GRHC, 2016).

Further, there are both extensive and intensive green roofs. The organization Green Roofs for Healthy Cities, finds that extensive green roofs are a bit simpler and lower maintenance. They are usually covered in low profile plants like grasses, mosses, and succulents. Extensive green roofs have a shallower planting medium due to the plants'

shallower root systems, and therefore bear a lighter load of about 10-25 pounds per square foot, for the base roof structure to carry (Adams et al, 2008). The Green Roofs for Healthy Cities report also notes the limitations on access to extensive green roofs because they are not intended for gathering or walking on, other than for maintenance. Further, extensive green roofs usually require little maintenance because they tend to have a lower diversity of plant species, simplifying care (GRHC, 2016). One technique that Green Roofs for Healthy Cities cites as a simplification of care is the use of perennial and drought resistant plant varieties to curb the need replanting each year and watering beyond natural rainfall (GRHC, 2016). Although, extensive green roofs have a lesser loads and costs, they lack some of the social benefits and opportunities an intensive green roof provides.

Intensive green roofs are similar to extensive green roofs except they are much more elaborate. Intensive green roofs include more variety of plants like taller grasses, shrubs, flowers, and even small trees (GRHC, 2016). Green Roofs for Healthy Cities contrasts the accessibility to the previously mentioned extensive green roofs, saying how intensive green roofs often include walking paths and gathering space in their design because they are meant to be enjoyed and utilized by people as a natural feature and public space. The purpose beyond basic level planting is why intensive green roofs are also known as rooftop gardens (GRHC, 2016). Although they have many enjoyable qualities, intensive green roofs are also a lot more complex than extensive green roofs. Allen, an expert urban gardener, details the amount of labor that goes into planning, designing, and executing an intensive green roof. He goes on to lay out requirements like daily pruning and drip irrigation systems that increases costs and roof load making them more daunting for beginners (Allen, 2016).

Using Rooftops for Farming

Although the benefits of both intensive and extensive green roofs have been significantly researched and supported, there is little scholarly coverage of rooftop farming. Rooftop farming and gardening share the same benefits of conventional green roofs, while also serving as a tool for a more sustainable and equitable food system, especially in urban environments (Feenstra, 2009). The World Bank reports, urban populations are on a steady rise. Over the past 50 years, the United States has increased from a 70% urbanized population to approximately 82% urbanized population (World Bank, 2015). As urbanization steadily rises, farmland is steadily declining as arable land is being lost to development. The Farmland Information Center found that 5.4 million acres of farmland were converted to developed land between 2002 and 2012 (Farmland Information Center, 2016). To feed the growing urban population and improve food access to all populations, local food systems can become the sustainable alternative to our current food system. Feenstra finds that local food systems enhance the social equity of food, as well as the economic viability of the food system for farmers and consumers (Feenstra, 2009).

Urban agriculture is often considered an alternative food production method, but there are some problems with conventional urban agriculture. Acquiring an area of land in a city that is both large enough to be a productive farming area and is also not contaminated past the point of qualification for food production is extremely difficult (Chen, 2016). Additionally, the National Alliance to End Homelessness states the dire need for housing in cities. With overcrowding and homelessness as a constant concern, the development of new housing takes precedence over urban food production (NAEH, 2016). To address both needs of housing and local food, an alternative to traditional urban farming is rooftop farming. Wilkinson et al. write that, up to 32 percent of horizontal surface area in dense urban areas are roofs, which otherwise go unused.

Wilkinson et al. also point to the issue of urban soil contamination by heavy metals, and bioaccumulation by plants as a danger to consumers. Cadmium, chromium, lead, zinc, mercury, and arsenic are some of the most dangerous metals often found in urban soils, due to exposure to industrial pollution and heavy road traffic (Wilkinson *et al.*, 2016). The biggest risk for soil contamination is on the street level due to gasoline and diesel fuel exhausts, so rooftop farming is a safer alternative especially because the planting medium will be specifically chosen to suit the environment and plants, and can be more easily controlled (Wilkinson *et al.*, 2016). Moreover, Feenstra points out that local food and urban agriculture will reduce the amount of road traffic and resultant pollution related to food distribution (Feenstra, 2009).

Decentralizing food production and focusing on the development of local food is slashing the food miles by an extreme percentage. A presentation by Beck et al. shows how local food cuts out the transportation from the farmer to the food hub, from the food hub to grocery stores and other distributors, and then from the grocery store to the consumer. Each of these steps more often than not occur by truck, car, train, and ship burning fossil fuels and producing greenhouse gases in the process (Beck *et al.*, 2016). Beck also notes the reduction of greenhouse gas emissions by reducing food waste that would decompose anaerobically in a landfill, producing greenhouse gases. Food waste is reduced by not having to transport food, and without grocery store standards of food appearance, which accounts for the loss of 30-50 percent of food between the farmer and the consumer (Beck *et al.*, 2016). Returning to Wilkinson et al. they find that focusing on small scale agriculture deviates from the norm of massive monoculture food production and cultivates renewed crop diversity. An increase in crop diversity not only exposes consumers to unconventional foods, but will also improve soil quality by diversifying the micro nutrients depleted by different plant varieties, as well as the macroorganisms attracted by diverse plant varieties (Wilkinson *et al.*, 2016). In addition to soil

health, crop diversity as well as strategic integrated pest management would reduce the need for any type of synthetic pesticides or herbicides, further improving the quality and safety of any produce harvested (Wilkinson *et al*, 2016).

To all but completely curb the supply chain miles involved in food access, rooftop farming is especially suited for residential buildings. By placing rooftop farms atop residential buildings, the food miles from production to the consumer's kitchen is reduced to a few flights of stairs or a short elevator ride (Wilkinson *et al*, 2016). Housing development is the top priority for urban communities which are especially affected by overcrowding and homelessness (NAEH, 2016). By placing rooftop farms on housing developments, competition for land is replaced with collaborative development, beneficial to the residents and surrounding community. Further, Nettler's report on urban versus suburban housing costs finds that housing prices have risen at higher rates in urban centers at an 11.3 percent increase from 2011 to 2012, compared to only 10.2 percent increase in suburban housing costs. Further he found that housing prices in ethnically diverse urban neighborhoods rose even more drastically by 14.3% in the same two year period (Nettler, 2013). As housing costs in urban centers rise, the need for affordable housing developments is crucial. Practicing urban agriculture on the roofs of affordable housing developments provides residents of lower income, who may be more vulnerable to lack of access to affordable high quality produce, convenient access to high quality produce without stepping outside of their building. Additionally, placing rooftop farms on a residential building is dually beneficial to the residents and to the farm because residents of the building desire the fruit and vegetables of the farm or garden, and the garden or farm has a built in community to maintain it (Wilkinson *et al*, 2016).

Environmental Benefits

The two top arguments for implementing green roofs is the mitigation of both storm water runoff and urban heat island effect. Urban heat island effect is a growing problem in urban areas where flat black surfaces and an overall lack of shade has lead to significant temperature increases in urban centers, compared to rural and suburban areas. Environmental Protection Agency (EPA) estimates that due to increased black surfaces, especially on roofs, radiation from the sun is absorbed as heat at much higher rates, causing roofs to be up to 90 degrees fahrenheit hotter than the surrounding air temperature in peak summer heat (EPA, 2008). From the extreme heat of rooftops and flat black surfaces, the heat in urban centers can be five to ten degrees fahrenheit warmer than their suburban and rural neighbors. A report prepared by Gruzen Samton Architects (GSA) for the City of New York warns that the increased urban temperature can even affect weather, contributing to increased probability and intensity of summer storms (GSA, 2007). On the other hand, GSA offers the alternative of lightly colored and reflective surfaces, as well as green roofs to reduce the urban heat island effect by reflecting rather than absorbing radiation from the sun. Reflective and lightly colored roofs may only get 15 degrees hotter than the ambient air in peak summer heat (GSA, 2007). However, EPA points to the benefit of green roofs cooling the surrounding air by up to 38 percent in hot summer months by evapotranspiration of vegetation (EPA, 2008).

Further, GSA suggests green roofs as a stormwater runoff mitigation strategy (GSA, 2007). The now defunct Environmental Affairs Department of Los Angeles explains how stormwater runoff is a growing problem in cities due to the increased land coverage by impermeable surfaces and roofs. The report continues to warn of the threats of stormwater runoff saying, it can be both physically dangerous because of flash flooding, and environmentally dangerous as stormwater runoff captures pollution, toxins, and waste from the

city and transports it to beaches and marine ecosystems (EADLA, 2007). In order to comply with both the National Pollutant Discharge Elimination System and the Clean Water Act, cities must implement techniques to reduce stormwater runoff, and green roofs are one option because they can absorb and retain stormwater directly through the soil. Adams' costs benefit analysis of green roofs proposed the recycling of rainwater for irrigation through rain water collection apparatuses, the combined efforts allowing them to retain 10 to 100 percent of precipitation (Adams *et al.*, 2008)

In addition to the potentially cost saving environmental benefits of urban heat island mitigation and stormwater retention, green roofs also provide more environmental benefits like nurturing of biodiversity and air quality improvement. Latty's chapter in Wilkinson's Green Roof Retrofit: Building Urban Resilience details how green roofs act as an urban sanctuary habitat for native species that would otherwise be driven out by the increasing rates of urbanization. Urban green roofs can also act as links between areas of more pristine environment to improve habitat connectivity, a crucial aspect to protect species biodiversity and survival when habitat fragmentation is a growing problem due to urbanization (Latty, 2016). A study by Bauman focuses on the important role of green roofs for urban birds saying they are especially helpful for biodiversity of birds and bats, as winged vertebrates can most easily access roof tops. Rooftop green space is also known to be nesting sites for endangered species such as the Northern Lapwings in Europe and parts of Asia (Bauman, 2006). Additionally, rooftop green space fosters diversity among insects, especially if native plant species are used. In her chapter, Latty continues on to say how crucial green roofs are for bees, which have been experiencing catastrophic colony collapse in recent years. Bees are substantially helpful as pollinators in ensuring the success of the green roof itself, a symbiotic relationship (Latty, 2016). Clarke's coverage of a Queens, NY housing complex with a rooftop farm adding a hive containing more

than 13,000 bees to their project, further proves the key ecosystem services bees can provide (Clarke, 2015).

Also in New York City, an organization is tackling air quality through the promotion of green roofs. Sustainable South Bronx is located in an area with some of the highest rates of asthma in the country due to the emissions of diesel trucks in the food distribution and waste removal industries. They are promoting green roofs especially because as one study by Yang et al. found, intensive green roofs can remove more than 100 metric tons of pollution per hectare, with the main pollutants being removed being ozone, nitrous oxide, fine particulate matter, and sulfur dioxide (Yang *et al.*, 2008). Green roofs also reduce pollution by decreasing the need to heat and cool the building artificially, thus reducing the amount of fossil fuels consumed overall (Akbari, 2001). Similarly, the reduction in citywide heat significantly reduces smog exposure. A study conducted by the Heat Island Group at Lawrence Berkeley National Laboratory found that in Los Angeles, planting three trees per house would reduce the temperature of the city by two to three degrees celsius. That amount of air temperature reduction would reduce the smog exposure by roughly the same amount as removing the entire basin's on-road vehicle exhausts (Akbari, 2001).

Development Benefits

Aspects of green roofs that have been found to be beneficial to the environment and the institution can also be elements of green roofs that make them economically beneficial. First, GSA's report for the City of New York finds that green roofs extend the life of a building's roof because the plants and growing medium protect the structure and membranes from harsh elements. Also, contrary to popular belief, green roofs actually prevent roof leakage by protecting the roof's waterproof membrane from UV exposure (GSA, 2007). The extended roof

life of green roofs makes up for the longer pay off period of higher upfront costs. Additionally, green roofs provide a significant reduction to heating and cooling costs. The NYC Department of Design & Construction found that in New York City, at 2004 energy rates the implementation of green roofs would reduce energy use by about \$0.07/sqft for new buildings and about \$0.18/sqft in buildings built in the 1970s or 1980s. They also predict this savings would be higher for buildings built before the 1970s, and also for buildings in warmer climates (NY DDC, 2007). These savings may seem meager considering the payback period of green roofs, but the energy savings do not consider the energy reduction from reduction of urban heat island effect. When the reduction of urban heat island is considered, even on new energy efficient buildings, the NYC Department of Design & Construction estimates a green roof will pay itself off in energy reduction costs in roughly six years (NY DDC, 2007).

Moreover, green roofs are also a huge contribution to the point system for Leadership in Energy and Environmental Design (LEED) certification. According to the U.S. Green Building Council, green roofs can contribute at least two and up to thirteen points toward LEED certification, and reduced energy consumption due to green roofs can contribute as many as nineteen points. Combined, green roofs can account for up to 40% to 80% of the 40 to 80 points needed for certification depending on the desired certification level (USGBC, 2016). The strong contribution to LEED certification is especially important considering many cities like the city of Los Angeles require LEED certification for buildings over 50,000 sqft (Menzer *et al.*, 2008). In addition to LEED certification standards, green roofs can provide a positive image associated with corporate social responsibility (Wilkinson *et al.*, 2016).

Social and Health Benefits

Despite their costs, green roofs provide countless opportunities for the building beneath

it. On a very basic level, Wilson *et al.*, popularized the idea of biophilia, meaning that humans have and seek an innate connection to nature. According to this theory, exposure to nature can have benefits such as stress reduction, increased productivity, and public health benefits as a result of the environmental advantages of green roofs (Wilson *et al.*, 1984). Further, a report from Community Food Security Coalition intending to build communication between urban gardeners and health professionals found that growing food and other crops in an urban environment improves overall well-being and health of communities. Bellows *et al.* continue on to elaborate how cultivation activities trigger an immediate mental illness prevention and healing response. The act of urban gardening was found to reduce stress levels, anger, fear, and blood pressure, because it is an act of self care (Bellows *et al.* 2016). Another report developed by Surls *et al.* found that urban gardening also built self esteem by using self determination and decision making skills, as well as social skills by working together with others and building communal pride (Bellows *et al.* 2016)(Surls *et al.* 2016).

The sense of teamwork and pride is not the only community benefit of rooftop or urban gardening. Surls *et al.*, as well as Bellows *et al.* found that a communal gardening space fostering cross cultural and generational communication and understanding (Bellows *et al.* 2016)(Surls *et al.* 2016). Surls *et al.* also found that this growth in communication and understanding lead to empowerment and increased citizenship. From empowerment comes an increase in community activism (Surls *et al.* 2016). A report from the MIT Department of Urban Studies and Planning found that this activism was borne out of the idea of placemaking (Silerberg, 2013). Project for Public Spaces defines placemaking as, "Placemaking inspires people to collectively reimagine and reinvent public spaces as the heart of every community. Strengthening the connection between people and the places they share, Placemaking refers to a collaborative process by which we can shape our public realm in order to maximize shared

value” (PPS, 2017). Silerberg goes on to connect placemaking to a sense of ownership of one’s communal environment and the development of environmentalism among members of a community. Banerjee, cites communal green spaces as the catalyst to promote urban democracy, civic pride, and sense of freedom. Elements that make up the foundation of urban communities (Banerjee, 2001).

When communities come together to take ownership of the quality of their environment, Bellows et al. finds that the health of a community as a whole improves. Communal gardening promotes active lifestyles because it is a form of low stress exercise and reduces risk of obesity (Bellows et al. 2016). Additionally, Surls et al. finds that growing your own fruit and vegetables or living in a household with someone else who grows fruits and vegetables makes everyone in that household 3.5 times more likely to eat five or more servings of fruit and vegetables each day. The increase in fruit and vegetable consumption is especially important in low income populations that sometimes rely on emergency food supplies like food banks, because emergency food sources stock more high calorie items like grains and canned goods, than fresh produce (Surls et al. 2016). Bellows et al. then describes how growing one’s own fruit and vegetables increases awareness of seasonality, produce quality, and variety leading to healthier dietary habits. Further growing one’s own vegetables and fruits also promotes sharing with family and community members because the fruit or vegetable is something that the gardener made personally with his or her hands (Bellows et al. 2016).

While increasing healthy eating habits, growing one’s own food also decreases food related costs each month. Bellows et al. found that in a 130 day growing season in a temperate environment, a 10x10 meter plot produces nearly enough vegetables to support a family of five for an entire year. The study goes on to quantify the cost benefit further finding that each dollar invested in a garden plot creates a return of six dollars worth of vegetables (Bellows et al.

2016). While Surls et al. finds that gardeners save up to \$475 annually on fruit and vegetable costs (Surls et al. 2016). Additionally, the aesthetic advantages of a rooftop garden can make the building incredibly appealing to consumers or people seeking housing, and increase the overall value of the building (Green, 2017).

Challenges

The biggest challenges associated with implementing a green roof to an urban building are the costs associated with the design, installation, and maintenance. When costs are considered in terms of roof life, green roofs are more expensive per square foot in most cases (LAEAD, 2007). Referring to Figure 2 Below, the now defunct City of Los Angeles Environmental Affairs Department found that an intensive green roof retrofit costs \$1.66 per square foot annually, compared to \$0.51 per square foot annually for a standard black tar roof. However, the cost of a high end roof is higher than that of an intensive green roof at \$1.74 per square foot annually. For new roofs, green roofs are also more expensive than conventional roofs. A new intensive green roof costs about \$1.00 per square foot annually which is more expensive than even a high end roof at \$0.78 per square foot annually (LA EAD, 2007).

Figure 2. Cost Comparison (per sqft)	Retrofit/Reroof				New Installation			
	Green Roof		Conventional Roof		Green Roof		Conventional Roof	
	Low End	High End	Low End	High End	Low End	High End	Low End	High End
Initial Cost	\$15.00	\$25.00	\$5.00	\$20.00	\$10.00	\$15.00	\$3.00	\$9.00
Roof Life	35 years	40 years	15 years	20 years	35 years	40 years	15 years	20 years
Initial Cost Annualized Over Roof Life	\$1.03	\$1.66	\$0.51	\$1.74	\$0.69	\$1.00	\$0.31	\$0.78

(LA EAD, 2007).

In addition to the cost of the roof itself, there are the costs associated with the green roof

design consultants and architects. Farmscapes, an urban agriculture company in California charges a \$150/hr consultant fee for their projects, as well as about \$20k for the design and installation of large scale farming projects. Ongoing costs amount to about \$50 to \$70/week for maintenance (Allen, 2016). There are ways to reduce costs by employing a maintenance staff member within the institution, but in all cases there are additional costs associated with green roofs in comparison to a conventional tar roof. A study by Henrickson out of the University of Missouri also found from interviews with urban farmers that access to capital is a key barrier to farming on roofs. Henrickson also notes how federal agencies like Department of Housing and Urban Development (HUD) and EPA are progressing too slowly when it comes to funding greenroof projects. Even though the US Department of Agriculture has some funding like the Community Food Projects Competitive Grant, it is not enough to cover the cost of larger scale projects (Henrickson, 2012).

Additionally, a needs assessment for urban agriculture in California by Surls et al. found that central barrier for farmers working on roofs is a lack of access to information. Rooftop gardening or farming is beyond the scope of community garden demonstrations, and there are few large scale rooftop projects to learn from (Surls et al., 2016). Lastly, Wilkinson et. al addresses the concern about eating produce grown on a green roof in heavily polluted urban areas. Many dense urban areas are more heavily polluted due to industrial activity and heavy road traffic. One study of the the resilience of green urban environments notes how plants have the ability of bioaccumulating pollutants and contaminants, which is positive for the environment, but could be a problem for consumers of produce grown on urban green roofs (Wilkinson et. al, 2016).

Background and Case Studies

Financing Opportunities

Green roof projects typically rely on grant funding through public and private sources. There are various grants offered by federal agencies that are larger in size and scope and would be best utilized for the costs of development and construction. For smaller grants to support sustained income for tools and programming, there are non-profit organizations and corporations that provide small to medium sized grants.

Currently, the key federal grants to fund large portions of project costs are the HUD Community Development Block Grant, HUD Sustainable Communities Regional Planning Grant, EPA Clean Water State Revolving Fund, and DOE Weatherization and Intergovernmental Grants. The HUD Community Development Block Grants are awarded to projects that provide decent affordable housing and services and job opportunities to the most vulnerable, especially in low-income or blighted areas. Additionally, the grant also puts a lot of emphasis on citizen participation through all aspects of development and operation. The size of the grant depends on the Department of Housing and Urban Development's assessment of need, but grants are pulled from a fund of about \$3.2 billion dollars annually and are awarded to approximately 1,200 grantees who spend the funds over a course of one to three years (Beck *et al.*, 2016). Similarly, the HUD sustainable communities regional planning grants are awarded to projects that find synthesis between affordable housing and unconventional partners that translate to livability and sustainability. In this case, the unexpected partners are food systems and urban agriculture. This grant focuses on collaborative efforts and that support communities in comprehensive ways (Beck *et al.*, 2016).

In addition to the two key grants from HUD, EPA Clean Water State Revolving Fund supplies low-cost loans that are matched at 20 percent by the state, to fund water infrastructure

projects. It's function as a revolving fund means the principal and interest paid off on each loan will go into a state fund that will repurpose the funds for additional water infrastructure projects in the future. A rooftop farm is an example of water infrastructure for its ability to absorb and filter stormwater runoff in urban areas. Also, the Department of Energy supports a grant for weatherization to improve the energy efficiency of a building. Through mitigation of urban heat island effect and as an element of insulation, green roofs can greatly reduce the amount of energy needed to heat or cool the building below it, something that is especially important for a multi-family building such as an affordable housing complex (EPA, 2016) .

To supplement larger funding sources, small and medium size grants can be useful for materials, maintenance, and tools to ensure the most efficient operation of the farm over time. Some example are the Home Depot grants which are dedicated to funding projects that impact low-income housing and are opportunities for volunteering. Home Depot works with particular projects by providing tools, materials, gift cards, and volunteer labor accumulating to as much as \$5,000. Seeds of Change is another organization that supplies raw materials. Seeds of Change is devoted to providing a diverse seed pack for non-profit projects, seasonally. In terms of small sources of funding, Lowes Community Partner Grants and Community Food Projects Competitive Grant Program both provide grants approximately \$10,000 to \$25,000. The Lowes grant is designed to fit any type of project that works to improve communities, while the community food projects grant is specifically focused on improving food access for low-income communities, which is also a specific goal of a partnership of affordable housing and rooftop farming (Bruna *et al.*, 2013).

In addition to grant opportunities, many rooftop and urban farms have developed farmers markets or CSA programs to sell the produce to a wider audience. Sankofa Apartments and Farm in Providence, RI has created a world market (Vincola, 2016). The world market sells

produce and prepared foods native to the local diaspora communities' ethnic backgrounds. The goal is not only to sell their produce, but also to spread cultural knowledge among different diaspora communities in the area (Vincola, 2016). In Harlem, NY, NY, one affordable housing development leases small portions of their rooftop farm for use by other local urban farmers to accrue a modest amount (Bruna *et al.*, 2013).

As well as opportunities for funding, there are a few ways in which rooftop farming is incentivized. Most cities, including Los Angeles, have an incentive program to encourage projects that help control stormwater runoff. In Los Angeles, there is a formal stormwater mitigation plan that cites urban green space as a priority for reducing the volume and toxicity of stormwater runoff. Each project is evaluated on a case by case basis to estimate the amount of stormwater the roof will have the ability to retain. One study by the city of Seattle found that intensive green roofs had the potential to retain up to 65 percent of the peak storm flow capacity (SPU, 2012).

In terms of upfront costs of implementing a rooftop farm, there is a range of cost estimates based on the conditions, location, and climate of the roof in addition to the materials and plants selected. Eagle Street Farm in New York City, estimates their project cost only \$10 per square foot, but cites the easy access of the roof and use of recycled materials as the measures keeping costs down (Novak, 2012). Based on several rooftop farms throughout the city, Portland Bureau of Environmental Services estimate a cost of approximately \$10-\$25 per square foot when you include materials, labor, and roof structure upgrades (Adams *et al.*, 2008). Lastly, Sugar Hill rooftop farm in Harlem, NY estimates approximately \$15 per square foot and shows that more recent projects have lower costs because of a greater wealth of specialized knowledge and labor in the field (Bruna *et al.*, 2013). From the three different estimations, the costs of a rooftop farm are between \$10-\$25 per square foot of roof space, compared to a

conventional roof that costs between \$3-\$20 per square foot. The variability of cost is based mostly on soil depth and materials used for edging and membrane layers. In addition to upfront costs, Sugar Hill Farm budgets \$32,500 annually for a full time farm manager. The farm manager accounts for most of the labor and organization costs, but additional costs for new seeds, fertilizers, repairs, etc. are difficult to estimate as it varies on a case by case basis. Sugar Hill farm recommends factoring ongoing rooftop farm costs into the general funds of the affordable housing development below (Bruna *et al.*, 2013).

Stakeholders and Regulators of Planning and Development

Because green roofs, as well as rooftop farms, are projects with very comprehensive inputs and benefits, it is a logical conclusion that they also have a vast pool of stakeholders. First off, there are various types of regulators involved. For green roofs, building code and public health regulators are key stakeholders because the significant increase on roof load needs to be thoroughly examined to ensure its safety. Additionally, public health regulators are involved because green roofs are a public health benefit, specifically through increases in air quality and access to outdoor amenities. For both building codes and public health, a key issue when building green roof is ensuring accessibility but also easy evacuation determined by the fire department, to ensure the safety of all parties involved. If the green roof is used for food production then food safety regulations are also taken into account. Food safety regulation are mostly to do with the types of treatments (herbicides, pesticides, fertilizers, etc.) that are applied to crops and potentially consumed.

After regulators, there are urban and regional planners. Planners have the widest scope of interest in green roofs because they are concerned with how the green roof will contribute to the long term livability and sustainability of the city. Planners will influence policy that focus on the social, economic, and environmental aspects of green roofs (Wilkinson *et al*, 2016). After

urban planners are the developers and/or owners of the building. They have the greatest interest in the success of a green roof because it sits on top of their building. As the owner/developer of the building they also have the most responsibility in terms of funding and managing the green roof. They also have the liability of the failure of the green roof, as well as potential structural maintenance or leakage. However, they enjoy the benefit of having so called “green bling” on their building (Wilkinson *et al.*, 2015). Beyond the developer or owner of the institution with a green roof, is the staff they hire. The key staff are a program manager and expert farmer. Both are important to guarantee the green roof runs smoothly and is being used to its fullest potential. The program manager’s central responsibility would be programming, such as educational partnerships with schools, classes in nutrition or horticulture for adults, and possibly using the roof as event space. Additionally, they would have responsibility of outreach and marketing, as well as long term funding if necessary. The farmer is equally as important because they maintain the green roof once volunteers and programs are finished. They take on the responsibility of keeping the green roof alive when other contributors are not enough (Bruna *et al.*, 2013).

As previously mentioned, the manager would have responsibility of finding funding sources to maintain the roof over time. Funding typically comes from small to medium size grants or donations, tax incentives, and federal grant programs from the Department of Housing and Urban Development and Environmental Protection Agency. In addition to funding sources, it is important to collaborate with external entities, especially in the early stages of the green roof or farm, as made clear through the recommendation of Sugar Hill Housing Development. They found that in the early stages it is best to work with a consultant to work with the building architect to ensure smart designing to best utilize the combination of sun exposure, drainage, water access, and accessibility (Bruna *et al.*, 2013). Additionally, it is important to discuss what

will be planted on the roof with the consultant and residents. This is increasingly important if the green roof will be used for food production for residents, because it increases their ownership of the garden and increases their likelihood of eating said produce by 3.5 times (Surls et al., 2016).

Lastly, and arguably the most important of all stakeholders are the beneficiaries. These are the people who the green roof or rooftop farm are designed for. There are ways to increase the ownership and activity of the beneficiaries such as asking for input as to what should be planted or creating a key role in the maintenance or cultivation (Silerberg, 2013). For the case of a food producing green roof, there are more beneficiaries because many people are eating the produce harvested, whether that is through a restaurant, a community supported agriculture (CSA), a farmers' market, etc. (Vincola, 2016). The beneficiaries could also benefit in ways other than food access, such as increased access to green space, improved health, volunteer or educational opportunities, and more. As a comprehensive project with effects across social, economic, and environmental plains, beneficiaries are by far the largest stakeholder group of a green roof (Bruna et al., 2013)(Wilkinson et al., 2016).

Rooftop Farms on Affordable Housing Development: Case Studies

In other cities across the U.S., rooftop farming at affordable housing developments is already successfully providing access healthy fresh produce to low income residents. Many of these projects are in cities where it regularly snows, because roofs are already built for a heavy weight load, making retrofit to a greenroof less difficult. Three housing developments, two in New York City and one in Providence, RI serve as examples for Los Angeles developers to be inspired by. One innovative affordable housing development with a rooftop farm is Sugar Hill Housing Development in New York City. Sugar Hill shared several findings to make rooftop farms feasible for affordable housing developments such as phasing development, to distribute costs over a longer period and also acclimate staff and residents to the rooftop farm overtime

(Bruna et al., 2013). Additionally, they found programming was most successful when tailored toward specific age groups and should be deeply tied to the harvesting process. Lastly, one finding that they stress is the need for consistent care and maintenance which is best achieved by having a full time employee as a garden manager and program organizer (Bruna et al., 2013).

Another affordable housing complex with a rooftop farm in New York City is called Intervale Green. The housing development is located in the Bronx borough of New York, which has some of the country's highest rates of asthma due to air pollution. The original intent of the rooftop farm was to utilize its ecosystem services to help clean the air around it, while also providing access to produce to their residents (Intervale Green, 2016). However, beyond simple access to fruits and vegetables, the farm is an opportunity to create a profitable farmers market for the housing complex and surrounding community (Intervale Green, 2016). From May to October, the housing development has a monthly farmer's market to share the fruits of their labor on the rooftop farm with members of the community. Produce sold at the market were harvests that exceed the amount harvested and consumed by the residents of the building. While sharing with the community, the farmer's market also provides supplemental funds to help provide supplied and programming involving the rooftop farm. The programming is well loved by residents, this past October they held a pumpkin carving, seed roasting, and seed saving workshop and so many residents attended that there were not even enough pumpkins for each individual to have their own (WHEDco, 2016).

In Providence, RI another housing complex also uses their urban farm to supply a farmers' market, but with a global angle by providing produce native to local immigrant communities cultural background. The global market not only provides produce that diaspora communities may not be able to find in a conventional grocery store, but it is also an opportunity

for people of different cultural background within the same community to come together and share their culture with each other (Vincola, 2016). Additionally, rooftops themselves are an educational opportunity. The same farm, Sankofa Initiative, in Providence also provides an educational program for children about farming and healthy eating. For adults the farm provides volunteer and job training opportunities providing participants with employable skills in agriculture, sales, and management (Vincola, 2016). The Sankofa World Market is an example of the type of cross cultural communication and sharing that Surls et al. found crucial to healthy communities in Los Angeles. Additionally, the Sankofa initiative provides an example of how a master gardener can be staffed at an affordable housing development in a financially efficient way. Sankofa staffs a master gardener on-site by offering a small stipend and also reduced rate for rent of one of the apartments on site. This alternative benefits the development by saving costs of employing another full time staff member as a gardener, and also provides a high quality and affordable living opportunity for the master gardener (Vincola, 2016).

Los Angeles as a Case Study

Housing and Food Insecurity in Los Angeles

Food security is a range of the availability of food households can afford and have access to. The issue in Los Angeles is the growing number of households that identify as either Low Food Security meaning a household has “reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake” (USDA, 2015). Many households in Los Angeles fall under this category of having food to eat, but food that is not necessarily of high quality in terms of freshness or nutritional value. Although members of Low Food Security households are not experiencing extreme hunger, lack of fresh nutritious foods is a public health risk that can affect many aspects of day to day life beyond what’s on the plate at each meal, such as

performance in school or work, or predisposition to chronic diseases like type II diabetes and obesity (Jyoti *et al.*, 2005). In 2010 more than half a million people reported some level of food insecurity. Further, over 200,000 households experienced very low food security meaning, “multiple indications of disrupted eating patterns and reduced food intake” (USDA, 2015).

Food Insecurity Rates for Families Below 300% of Federal Poverty Level	
Food Insecure	30.6%
Very Low Food Security	12.8%

The numbers don’t lie, food insecurity is a critical concern in Los Angeles County, and food insecurity is increasing over time. Over nine years from 2001 to 2010 the quantity of households identifying as very low food security increased by 66.2% (LADPH, 2015).

Households in LACO Identifying as Food Insecure	
2001	2010
7.7%	12.8%

(LADPH, 2015)

Simultaneously, housing in Los Angeles is progressively less affordable as the third wave in downtown growth and urban renewal has brought households back from the suburbs to urban centers. The new downtown Los Angeles is welcoming to professionals and the creative class, while the long time working class population is being forced out by the rise in housing costs (Romero, 2004). For example, in one downtown zip code the population grew a whopping 36% between 2000 and 2010, rents increased by an average of 73%, and home prices rose by 152%. In a single ten year period housing costs more than doubled. In addition to the huge boom in housing costs, Los Angeles has the lowest vacancy rate of all U.S. cities at an average

of about 3.1% over the last year (Phillips, 2016). The low vacancy rates makes housing not only expensive, but also competitive, adding further stress to the burden of housing in Los Angeles. An estimated 58.5% of Los Angeles County renters had a high housing burden, meaning they spend more than 30 percent of their monthly income on rent. When approximately 52% of the population are renters, this becomes a huge problem. In the past two years, 17.2% of households were unable to afford their monthly housing cost at least once (LADPH, 2015). The stress of housing cost burden is a public health risk to the population of Los Angeles, and when compounded with other public health factors many Los Angeles residents are left very vulnerable. Food insecurity is an example of a public health risk likely to accompany high housing burden. In Los Angeles, among households with incomes <300% of the federal poverty level who reported trouble paying housing costs at least once in the last two years, 56.9 percent were also food insecure, and 26.7 percent had very low food security. Low food security was more than twice as likely and very low food security is more than four times as likely among households burdened by housing costs, compared to households of the same income level that were not burdened by housing costs (LADPH, 2015).

In the city of Los Angeles, both food and housing are inequitable. The need for affordable housing is a constant concern for urban planners and policy makers, while simultaneously, so is food insecurity. For many people and families they are a compound issue. The unaffordability of housing in urban centers places a heavy financial burden on residents, and can contribute to food insecurity. Households should not have to choose between buying food and paying rent each month. In addition to a lack of food in general, there is also a lack of fresh, nutritious food to support a healthy lifestyle, which becomes an issue of public health and quality of life for residents of the city. Community gardens have been largely successful in bringing fresh high quality produce to neighborhoods vulnerable to food insecurity and

connecting residents to the land and the food they consume (Lopez, 2016). However, because the availability of affordable housing in Los Angeles is extremely limited, the first priority of any available land in the city would be for the development of more affordable housing. So where will the community gardens go? Well, think of looking out the window at the top of a skyscraper in Los Angeles. There are hundreds of flat, unutilized roofs throughout the city. These flat unutilized roofs are the perfect opportunity for a community rooftop farm. Further, affordable housing developments would be an appropriate stage for a rooftop farm, to serve both its residents and surrounding community. By integrating solutions to both the need for housing and healthy food, there is no competition for land between housing developers and urban farmers. Additionally, green roofs in general have numerous benefits: financial, environmental, and social that are more than enough reason to implement them citywide, in addition to their use as a means of local food production.

Housing Financing in Los Angeles

To understand the feasibility of amenities and services offered at affordable housing developments, such as rooftop farms, it is crucial to understand the financing of such projects because each specific source of funding comes with unique requirements and regulations for developers to abide by. In Los Angeles, The Low Income Housing Tax Credit (LIHTC) is the primary way in which affordable housing developers finance their projects (Dillon, 2017). It is a federal government policy created in 1986 that allows affordable housing developers to sell the tax credits to investors in exchange for equity (HUD, 2016). The additional equity allows for increased development and rehabilitation of affordable housing without developers having to incur severe amounts of debt. The tax credits are allocated by the California Tax Credit Allocation Committee (CTCAC) (CTCAC, 2017) and they work on a period of ten years. There

are two types of tax credits: the 9 percent credit and the 4 percent credit (HUD, 2016). The 9 percent tax credits are the most competitive and are most frequently used for new construction projects. Over the course of the ten years the investor who purchased the tax credit will be allotted a tax credit each year equal to 9 percent of the project's initial construction costs (Keightley, 2013). The actual rates are adjusted each year so at the end of the 10 year period the credits are equivalent to approximately 70 percent of the total construction costs. The 4 percent tax credits are usually used on housing rehabilitation projects or new construction that are financed by tax exempt bonds (Keightley, 2013). The 4 percent rate fluctuates like the 9 percent tax credit over the ten year period. The total tax credit value by the end of the ten year period is approximately 30 percent of the project's total construction costs (Keightley, 2013). The 9 percent tax credit are much more competitive as they finance a larger portion of the project's total costs and they are only allocated by the CTCAC bi-annually. The less competitive 4 percent tax credit finance a smaller portion of construction costs and are allocated more frequently by the CTCAC, about four times per year (CTCAC, 2017).

To qualify for low income housing tax credits, projects must meet the 20-50 rule or 40-60 rule. The 20-50 rule means at least 20 percent of residents have incomes less than 50 percent of the area median income. Likewise, the 40-60 rules means at least 40 percent of residents have incomes less than 60 percent of the area median income, adjusted for family size (Keightley, 2013). However, most developers elect to have a larger portion, if not exclusively, low income residents as LIHTC can only be applied to the portion of the project that is income restricted (CTCAC, 2017). Once a development has qualified, there is a rigorous application process. The process runs on a point system, with eligible projects needing at least 117 points for a 9 percent credit and 98 points for a 4 percent tax credit (Stivers, 2017). Points are awarded based on elements of the development that go above and beyond standard housing. Some

examples are sustainability technology, exceeding income requirements, resident resources and amenities, and location near schools, grocery stores, or mass transit (CTCAC, 2016).

Though, no project can receive the full amount of points. The maximum number of points for a 9 percent credit is 138 points, and 116 points for a 4 percent credit (Stivers, 2017). When several projects have the maximum number of points, other factors such as amount of other sources of capital secured, and experience of the developer are considered (Ferguson, 2017).

The LIHTC has long been successful in Los Angeles because of the benefit it has provided to not only affordable housing developers, but also to key investors like community banks (Wides, 2007). LIHTC are a smart investment for banks because they are lower risk due to the rigor of the application process of housing developers (Keightley, 2013), and the tax credits are worth more dollar for dollar than the potential income earned from a different type of investment (Novogradac, 2010). The tax credits are so valuable because unlike a tax deduction that discounts the amount of taxable income, the tax credit simply reduces annual income taxes owed to the IRS, dollar-for-dollar (IRS, 2017). The LIHTC policy is crucial to keeping affordable housing development possible in California, especially since the dissolution of Community Redevelopment Agency in 2012 accounted for a loss of \$50 million toward affordable housing annually (McOsker, 2014)(Campbell et al., 2012). The state of California still has public funds available to invest in affordable housing, but that amount has been reduced by 67 percent to \$892 million annually between 2009 and 2015 due in part from the \$12 million cut to Community Development Block Grants and the loss of the CRA (Campbell et al., 2012). Simultaneously, LIHTC have invested over \$32 billion in California since its creation in 1986 (Dillon, 2017). However, the success of the LIHTC is in jeopardy under the new Trump administration. President Trump has promised to reduce corporate tax rates from 35 percent to 15 percent, reducing the tax liabilities of the banks that typically invest in LIHTC (Dillon, 2017). The

reduction in tax stress on big businesses has significantly decreased the value of LIHTC and is leaving developers uncertain how to make up unexpected gaps to finance their projects (Dillon, 2017).

Department of Mental Health, Health Neighborhoods

In 2014, the Los Angeles County Department of Mental Health (DMH) began an initiative focused on whole person care and community wellness called Health Neighborhoods. This is important to rooftop farming at affordable housing developments because access to healthy affordable foods is a crucial element of preventative care, and also consists of various other mental health and community health benefits laid out by Bellows et al. and Surls et al. The initiative started when the DMH recognized in a 2014 report that even the highest standard of clinical care is not sufficient on its own to promote comprehensive wellness (LAC-DMH, 2014). A Health Neighborhood has five defining components: Population level results, data-informed, addressing roots causes of trauma, partnership and community engagement, and increasing community capacity to prevent mental illness by working together with fellow members of their community (LAC-DMH, 2014). Within the community, services and strategies will be organized based on age and level of need. Examples of specific target groups are transition age youth, formerly incarcerated adults, and communities with high concentrations of underserved ethnic or cultural groups (LAS-DMH, 2016).

The Health Neighborhood initiative is made up of two models: the service delivery model and the community change model. The service delivery model focuses on improving the quality and accessibility of direct services, as well as increasing communication among providers to create a more efficient system of care (LAC-DMH, 2014). The service delivery model is mostly run through the Department of Health, Department of Mental Health, Department of Public

Health, and substance use disorder service providers (LAC-DMH, 2016). By promoting communication and collaboration between different service providers, the goal is to make referral and cross agency screenings more streamlined, as well as being more aware of what services are offered by other care providers. Increased efficiency, awareness, and communication will help to contain costs by reducing redundant services (LAC-DMH, 2016). The focus of the Community Change model is to address social determinants of health and community wellness through policy and system level changes (LAC-DMH, 2014). The Community Change model works to mobilize residents and partner with community based organizations, housing services, and educational institutions to identify and tackle root causes of community issues (LAC-DMH, 2016). The goal of partnering with several types of community entities is to provide services and resident engagement through infrastructure that residents are familiar with and trust (LAC-DMH, 2014).

Methodology

To answer the question of “How can rooftop farming on affordable housing developments be implemented as an attainable option for increasing access to affordable local produce in the city of Los Angeles, CA?” I conducted qualitative primary research. I conducted semi-structured interviews with affordable housing developers and other professionals involved in the process of implementing amenities to affordable housing developments in Los Angeles. First, I interviewed Emily Koo, Manager of Community Building at West Elmwood Housing and Development Corporation in Providence, Rhode Island. Koo manages an established urban agriculture initiative at an affordable housing development. I asked questions related to design, financing, programming, cost savings related to the benefits of green roofs, and the process of

getting to the secure place of success and sustainability they have reached. See appendix for full list of questions that guided the course of each interview.

Next, I interviewed affordable housing developers in Los Angeles that could potentially be interested in pursuing a rooftop farming project in the future. Los Angeles currently does not have any affordable housing developments that also have a full scale rooftop farm producing large scale quantities of produce. Many affordable housing developers such as WORKS and Skid Row Housing Trust have urban gardening and edible landscape components in some of their developments, so I interviewed developers from both organizations to understand why they have not pursued rooftop farming already, and if they would like to pursue it in the future. My questions focused on their previous or current pursuits of other types of urban agriculture, their hesitations toward rooftop farming, and specifics about their current affordable housing developments. Listening to the words of developers directly, gave the best sense of the landscape of affordable housing in Los Angeles and the direction of progress it is moving in. This context helps inform recommendations that work best for Los Angeles, specifically. Please refer to appendices A and B for a full list of interviewees and interview questions.

Findings and Analysis

Through conducting semi-structured interviews with several Los Angeles affordable housing developers, I have found their top barriers to implement rooftop farming as a method of improving food access to residents in their housing developments can be broken down by relevance into three main groups: cost, maintenance, and accessibility. Affordable housing developers value the services and amenities their developments are able to provide for their residents, but it is not possible to do everything on their limited budget. Food access and on-site food production are not top priorities for most affordable housing developers in the city of Los Angeles. Generally, developers recognize the importance of access to fresh foods and would

love to be able to offer urban farming or gardening initiatives at their projects. However, in reference to rooftop farming in particular, all interviewees expressed preference for ground level urban farming.

Rather than urban farming, amenities and services that developers are prioritizing are increasingly focused on health and wellness through direct health services, especially in permanent supportive housing and senior housing. The prioritization of health and wellness related services is due in part because of funding made available from the Department of Mental Health through the previously mentioned Health Neighborhood Initiative. For family housing, childcare and afterschool programming are top priorities, in addition to job training, financial instruction, and soft skills development workshops for adults. Furthermore, beyond on site amenities, trends that are shaping the development of new affordable housing projects is a shift toward mixed use buildings, transit oriented development, and larger developments with a greater number of residents.

Financing Opportunities

General financing, along with site acquisition, is the top concern of developers and one of the most difficult components of a project to secure (Henrickson, 2012). Financing new affordable housing developments has become significantly more competitive as funding sources consistently dwindle year after year. Following the 2012 dissolution of redevelopment agencies in California, public subsidy has been reduced by as much as one third with the loss of \$50 million annually (Campbell et al., 2012), says Jan Breidenbach, former affordable housing developer in Los Angeles and current professor of housing policy at Occidental College. “All public subsidy is now distributed through the city and county of Los Angeles, and there is not enough to go around.” The competition for public subsidy has become especially fierce, as

allocation of low income housing tax credit funding is largely based on public subsidy confirmed for the development before application for 4 percent or 9 percent tax credit funding. Lara Regus, Senior Vice President of Development at Abode Communities, says “every project receives the maximum amount of qualified allocation points. Who receives the funding is based on who has the most experience and public subsidy locked in.”

Procurement of funds is especially competitive for family and general low income housing developments because permanent supportive housing developments receive greater public subsidy to support disabled, veteran, and chronically homeless residents. Proposition HHH passed in November of 2016 prioritizes funding for permanent supportive housing that can finance about one third of the development costs before application for tax-credit financing and loans. Securing low income housing tax credit funding is a top priority for affordable housing developers because it is the most reliable. As Jan Breidenbach puts it, low income housing tax credits are saved from the “chopping block” because they are a crucial benefit to the banking industry. The banking industry relies on LIHTC as a low risk investment with a guaranteed reduction of their tax liability each year, for ten years after the opening of the development. Other funding sources like Affordable Housing and Sustainable Communities (AHSC) program that provides financing through the California cap and trade program, as well as a piecemeal selections of grant funding cannot be counted on as consistent or guaranteed sources of funding.

Concern for High Costs

The difficulty and unpredictability of financing for the development of affordable housing poses one of the key challenges to developers, but additionally there is a cap on spending per unit of housing developed for LIHTC projects determined by the California Tax Credit Allocation

Committee. The cap on spending makes it difficult to accomplish everything developers envision, especially because sustainability requirements advance each year while the spending cap remains the same. Lara Regus stated one of her biggest concerns when developing a new project is, “how can we do it all for the same price?” When many requirements and pressures for specific sustainability elements and certifications are already in place, adding additional non-required elements such as a rooftop farm seem out of reach. Having urban agriculture elements on-site do count toward qualified allocation points for low income housing tax credits as earlier described in the housing finance section, however they are not necessary to reach the maximum allocation of points. There are several cost elements that make developers wary of farming on the roof, such as additional waterproofing, loss of photovoltaic solar panels subsidy, and cost of making the rooftop accessible under the qualifications of the Americans with Disabilities Act and Los Angeles fire code. As Ben Rosen, Director of Real Estate Development for Skid Row Housing trust states, “it’s simply easier to do [urban farming] on the ground level. It costs less.”

Professional Upkeep and Leadership

In addition to physical elements of implementing a rooftop farm, developers are apprehensive of the additional costs of maintaining the farm. Recognizing that one of the key elements of a bountiful harvest is consistent upkeep, developers feel large on site urban agriculture projects of any kind must be managed by a master gardener. To make a rooftop or urban garden into a reliable food source the space cannot be managed by residents alone. For example, Francesca De La Rosa Director of Policy and Strategic Alliances at Women Organizing Resources, Knowledge, and Services (WORKS) reflects on one of WORKS affordable housing developments that has a 29 raised bed urban agriculture project. The project

at Park Williams Housing Development in Pomona, CA is a year-round edible garden that was run by a full staff at the time. When larger sums of grant funding were available to devote to the project in the past, WORKS was able to fund a master gardener as well as outreach, classes, and training surrounding urban gardening and healthy foods. These financially intensive elements made the 29 raised beds a huge success. Residents were growing bountiful harvests of crops native to their ethnic backgrounds and sharing traditional agriculture techniques with each other. Many residents were able to harvest large sums of food from the raised beds to feed themselves and their families. However, in recent years funding has become less available and WORKS is no longer able to staff a master gardener or fund extensive programming for the urban garden. While the raised beds are still in use, resident participation is varied and inconsistent. WORKS has found that residents, especially in family housing, are simply too busy to grow and maintain their own garden bed for food production. De La Rosa went on to share, “you know, after a long day of work I can understand not wanting to get home and spend my evening with my hands in a garden bed.”

The Relationship Between Financing and Developers

The shortcomings of affordable housing finance paired with pressure by the city and need of residents to develop more affordable housing has put developers and site managers into a difficult position of being at the mercy of their funders. Depending on the investor or type of grant there are specific restrictions or guidelines for how the funds can be utilized. This can limit the creativity of developers, and also steer the direction of affordable housing development in general. The specification for how to utilize funding can explain the general trend toward direct health services. The Health Neighborhood initiative has heavily influenced this trend in services and amenities offered because public subsidy and federal grant funding has become

available through health agencies like LA Department of Public Health, LA Department of Mental Health, and LA Department of Health Services. Until the goals of the city as a whole shift or increased funding for affordable housing becomes available, developers continue to follow this trend toward direct health services. In cases where urban gardens have been implemented successfully at affordable housing developments like at Skid Row Housing Trust or WORKS, the garden has been a separate priority based on the mission of the affordable housing organization. Gardening projects, at this time, are predominantly funded through additional supplementary funds specifically designated for the project.

Design and Resident Participation

Both De La Rosa, and Regus find that resident participation in urban gardening projects is strongest at developments specifically for seniors. Retired residents have more time than families and working adults to devote to maintaining their harvest. De La Rosa has also observed senior residents getting involved with urban gardening as a social activity. She has noticed that creating a multi-use space that acts not only as an urban farm, but also as a public meeting space is more inviting and appealing to residents. By increased integration of trees, paths, and seating areas into the gardening area the residents used raised beds much more consistently. The increased consistency of use creates an environment for more successful harvests and production of quality produce.

However, at family affordable housing developments resident participation in all programming, not just gardening, is more varied and unpredictable. Parents and working adults tend to be busier, often working multiple jobs to make ends meet. Ami Pascual Spear, Director of Philanthropy at Mercy Housing recognizes that residents are often less interested in attending programs whether it be because they do not have the time, or prefer not to spend their free time

attending programs. There are many times that programming sponsored by the housing development have minimal attendance, depending on residents and case managers of the building. Daniel Huynh of LA Family Housing notes that participation of residents is largely dependent on the talent of case managers. When case managers have the ability to energize and connect with the residents, participation in programming is noticeably greater.

Accessibility and Safety

Considering the stronger interest of seniors in urban farming projects, access to rooftops is an additional concern of developers. Not only would ADA access to the rooftop be more expensive than a ground level project, but access to the roof is an increased risk for the residents. Ben Rosen of Skid Row Housing Trust expressed concern about the safety of the residents on the rooftop. If a resident were to be injured or have a health emergency on the roof it would be more difficult to have emergency responders assist the resident, and could extend the amount of time the resident is without emergency help. Additionally, Rosen worries about residents and farming interfering with HVAC equipment located on the roof. HVAC equipment is normally located on the roof to hide it from site, but it is expensive and crucial equipment that housing developments must keep unharmed. Ryan Lehman, a Senior Project Manager in a Los Angeles affordable housing organization also points out the difficulty of complying with fire code by keeping all items contained on roof four feet or more from the eaves. Additionally, Los Angeles fire code dictates roofs intended for public use must have more than one entrance and exit as groups of 39 or more individuals on the roof simultaneously are a possibility (Donneell-Kilmer, 2013).

Analyzing Use of Space at Affordable Housing Developments

It has become clear that use of space at affordable housing developments is complex and meticulously calculated. Availability of space is just as competitive on the rooftop as it is on ground level. Rooftop farms are not an answer to unutilized rooftop space, because rooftops are already being aptly used by affordable housing development in Los Angeles through solar installations and keen placement of HVAC equipment. Solar installations are a savvy use of rooftop space as they provide income through subsidy and tax incentive that a rooftop garden would not supply. Additionally, Lehman indicated there is a push toward energy net-zero buildings in the near future. Solar energy development is a key element to attaining the lofty goal, especially in Los Angeles. Also storm water attenuation and on-site containment is already built into affordable housing building requirements, so tax incentives that makes rooftop garden and green roofs appealing in other cities does not apply in Los Angeles. On the roof level, solar development is rooftop farming's greatest competitor, especially considering both a farm/garden and solar array seek high sun exposure, vying for the south facing area of the roof. On the ground level, the architectural strategy of the building to fit the greatest number of unit possible on the given lot poses the greatest competition to a garden, followed by other amenities such as playground, outdoor exercise space, and parking.

Resident Services, Programming, and Amenities

As previously mentioned, rooftop farming and community garden food production are currently not a priority in affordable housing in Los Angeles. This is primarily driven by a lack of funding due to finance guidelines and investor demands, not a lack of interest or awareness. Instead of urban agriculture, the current focus of resident services and programming are primarily focused on health and wellness. More and more affordable housing developments are including health clinics on site as well as athletic facilities and exercise classes. Increased

focus on wellness has seen the introduction of stress relieving resources like yoga, meditation, and cooking classes. Permanent supportive housing is especially focused on health and wellness, often providing personalized care and support. Mental health care and therapy is growing in popularity at affordable housing sites, especially in affordable housing developments.

In addition to health and wellness, on-site childcare and afterschool programs at family housing developments are a crucial element of their resident services. The Community Corporation Santa Monica partnered with the local Boys and Girls club to be able to provide after school care, classes, and tutoring for children living in their development. Community Corp has prioritized this partnership to work toward goals outlined in the Santa Monica Youth Wellbeing report card; specifically, the Learning & School Achievement aspect of the report card. The report card also focuses on Physical Health & Development, of which nutrition plays a key role. Lara Regus also emphasized the importance of childcare services, saying it was nearly a requirement for a family housing development. Family housing also often provides services targeted toward parents and working adults. Workshops for adults are often focused on financial education related to saving, budgeting, and car or home loans. Job training and resume workshops are also common programming targeted toward adult residents.

Recent Trends in Affordable Housing

As the budget for the development of new affordable housing becomes tighter and tighter trends focus mostly on cost impact. Some trends to address the cost impact has seen a shift toward transit oriented development (TOD). TOD is of greater importance, because not only does proximity to transit positively impact qualified allocation applications for tax credits, but it also allows developers to build fewer onsite parking spaces. Building parking structures or parking lots is often one of the more expensive components of construction. Developers are

also shifting their attention to mixed use spaces. As previously mentioned, many housing developments now have on-site clinics, but there is an additional push toward increased retail spaces and restaurants on the ground level of affordable housing developments. Restaurants and businesses pay market rate rent for their spaces, bringing additional revenue to the development. The focus on revenue has also caused a shift toward building larger developments. Larger developments not only provide more units of housing, which the city of Los Angeles is in critical need for, but a larger number of residents creates what Lara Regus of Abode Communities calls the “critical mass” needed to be able to offer and finance more resident services and amenities, such as on site gardening or farming.

Recommendations

From interviewing developers of affordable housing in Los Angeles, CA it is easy to gather their frustration with the requirements and limitations to the scant funding they receive for their developments. It is their understanding that in the current climate of affordable housing finance, the implementation of rooftop gardens is not possible in most circumstances. Instead of focusing on how to ensure affordable housing developers can implement rooftop gardens to improve access to healthy local food to residents, the following recommendations will be focused on ways developers can implement any type of on-site food production. The goal is not to see gardens on top of every affordable housing development in Los Angeles. The goal is to ensure the health and wellness of Los Angeles’s most vulnerable communities, in part through access to fresh and affordable fruits and vegetables at affordable housing developments.

Design and Resident Involvement

Designing an urban garden as a multi-use space is advantageous to its success. Multiple developers in the city of Los Angeles have observed higher rates of resident involvement in urban gardens when they are located in a space that is accessible and inviting to all, as well as being a practical meeting and socializing space. When residents can come to the garden to meet with friends or relax outside without the pressure of gardening, they are much more likely to use the space. When the garden is in use consistently, it draws residents in and becomes a significant community space. The community environment increases residents' personal value of the garden space motivating them to take care of their space and get involved in gardening. This idea shared by interviewees, supports the MIT report about placemaking that argues that when members of a community collaborate in their environment it leads to a greater sense of ownership, commitment, and environmental activism. Developers also found that at garden sites where resident participation was highest, it was because residents were using the space and gardening as a social activity. By designing the space to be multi-use and a public meeting space creates the ideal environment for resident participation. Thus, addressing the developer's concern of lack of resident participation, while also becoming an additional asset on-site staff can use for programming outdoors. Creating a multi-use space is simple. In addition to raised beds or other types of garden areas, urban gardens can include benches and open areas to meet or be active. Urban gardens are also a great place to display local art or host live music performed by community members.

Additionally, to increase resident participation it is important to gauge the interests of residents. There are several elements of the garden that can be tailored to residents interest like the crop varieties that are planted and what type of programming will occur. Sugar Hill Housing in New York City found that tailoring their programming surrounding their rooftop garden was

one of the best ways to ensure their success. Site staff can also ask residents what they would need to feel comfortable and energized to plant food for themselves and their family. Similar to the intent of creating a multi-use space to increase the value of the garden to residents, by including residents in the organization and programming surrounding the garden it increases its value to individual residents. When residents feel their opinion is valued and they have influence on their space it empowers them to actually use it and take ownership of their space, as asserted by Silerberg in the previously cited MIT report on the impacts of placemaking on environmentalism.

Partnership

Many developers expressed interest in partnerships, as developers and on-site staff typically do not have gardening expertise. With a local climate allowing for year round growing, Los Angeles is rife with community gardens and resources to get started. Groups like the Los Angeles Community Garden Council and the LA Food Policy Council: Urban Agriculture Working Group can work with housing developers to organize volunteers and mentors to get a rooftop or community garden started on site. Partnership with local volunteers and mentors can not only assist with the design and installation of the garden, but can also provide insight and training to residents as well as on site staff for the long term sustainability and success of the garden. Mentors can also be a long standing source of information to turn to when the garden faces obstacles over time.

For more intensive partnerships there are many urban farming ventures in the city of Los Angeles that will design and install urban farms and gardens. One such organization is Farmscapes, an Urban Farming Venture in California that would work with developers to design exactly what they envision. They have designed, installed, and maintained urban farms and

gardens for residential, corporate, and school sites. They also offer weekly maintenance. Their farm design and installation at the scale of a large multi-residential building costs approximately \$20K, which is a sum that could be covered by a one time philanthropic grant during construction. Weekly visits is an additional fee depending on the size of the farm, but is more cost effective than hiring an additional staff to tend to the garden. An additional option for regular garden upkeep is to offer reduced rent to master gardener living on site. The Sankofa Apartments in Providence, Rhode Island have successfully used this technique to ensure the upkeep and service to their garden beds. The option of reducing rent of a master gardener is also more cost effective than hiring a staff member to tend to the garden.

Navigating Policy and Funding Trends

The design and amenity components that are included in new developments is heavily influenced by how and by who the project is being financed. In recent years, many developers have focused on health and wellness because funding has been available through the LA County Department of Public Health (DPH), LA County Department of Mental Health (DMH), and LA County Department of Health Services (DHS). The funding available through these county agencies is available because of the Health Neighborhood Initiative that came out of the Los Angeles County Department of Mental Health's 2014 Strategic Plan. Because the latest focus and funding trend in affordable housing in Los Angeles focuses on wellness, and "whole person care" (LACDMH, 2016) a garden or rooftop farm can be shaped to be an amenity focused on positive health outcomes. Programming surrounding the rooftop farm or garden can be focused on healthy eating and lifestyle, a strategy of preventative care. Furthermore, the physical act of gardening as well as time spent outdoors has been found to have therapeutic qualities for proactive to mental health and self care. Specifically, Bellows et al. found that

gardening had an immediate impact on mental health healing and prevention responses. Garden programming can also include strategies of decompressing and self care through gardening which are beneficial to mental health and whole person health. Additionally, as funding is available often times through the DPH, green roofs and gardens play an active role in air pollution remediation. The successful rooftop farm at Intervale Green was developed and funded in part as a response to high asthma rates in the area. Improvement of air quality is beneficial in Los Angeles as well, with high rates of asthma especially in children under five and adults over age 65. Additionally, as the federal administration and policies change it is important to focus on how to cater to those changes. Other than the LIHTC that developers heavily rely on, developers may need to shift toward other options like funding from the department of mental health that is growing in Los Angeles lately. The decrease of corporate income tax from 35 percent to only 15 percent has made LIHTC much less valuable to investors, meaning housing developers are not getting as much capital investment in their developments for them. Further, Department of Housing and Urban Development that offers lucrative block grant programs like the Community Development Block Grant and the Sustainable Communities Regional Planning Grant took a harsh cut of 12 percent reduction in budget in 2018 (OMB, 2017). So now, more than ever, it is important to diversify sources of funding for the development of affordable housing projects.

Conclusion

In the city of Los Angeles, housing is a top priority with rapidly increasing housing prices, the highest rate of homelessness in the country, and the lowest vacancy rate in the country. Additionally, equitable food access is a problem that is often compounded with residents struggling to access healthy and affordable housing. A compound problem needs a

compounded solution. To improve food access to Los Angeles' lowest income most vulnerable residents, affordable housing developments need to consider and implement urban gardening programs to increase the availability of nutritious fresh foods to their residents. Whether affordable housing developments are growing food on the roof or ground level, is less important. Under the circumstances of funding trends and limitations in Los Angeles, implementing rooftop food production at affordable housing developments is not a viable option. Nevertheless, there are ways for developers to be creative with funding and partnerships to make on-site food production a possibility. The top priority is simply that fresh fruits and vegetables are being grown and consumed by the residents.

Although there is awareness about food accessibility and urban gardening, currently it is not a priority for affordable housing developers in Los Angeles. Developers have expressed their concerns, especially about the cost and roof space availability for such a project and more often than not rule out an intensive food producing garden as unfeasible for their development. Instead, developers are shifting towards offering direct health services as a result of the Health Neighborhood initiative in Los Angeles, and toward transit oriented development as a result of the Partnership for Sustainable Communities between HUD, DOT, and EPA.

The idea behind the Health Neighborhoods as well as the Partnership for Sustainable Communities is to take a comprehensive approach toward communities and well-being. Arguably, food access is a key aspect of comprehensive approach to the well being and sustainability to community in Los Angeles. As an element of sustainable communities, urban gardening is a way of increasing creating a localized food system. Local food systems, are more sustainable by reducing the supply chain miles food travels from farm to fork, as well as growing more responsibly using native crops and growing in season. Additionally, urban gardens are part of a sustainable community through their dual role as a public shared space. Placemaking

is an essential part to building community and generating community buy in into their local environment. As an element of whole person care, food is at the root of it all. The food we use to fuel and nourish our bodies is the foundation of health, as an element of preventative care. If all of Los Angeles' residents had access to health and nutritious fresh foods, the need for direct health services would be reduced. Low income folks are especially vulnerable to nutrition based disease like obesity, type II diabetes, and heart disease. With access to healthier foods, the risk for these diseases is greatly reduced.

On the county and federal level there has been a shift toward bigger picture problem solving, made clear through the Health Neighborhoods and Partnership for Sustainable Communities initiatives. Access to food needs to become part of the picture for both of these plans. Affordable housing developments already make an effort to offer the best services and amenities to support and benefit their residents, a shift toward on-site food production is the next step. Whether it occurs on roof level or ground level is unimportant. What is important is the availability of nutritious fresh food to residents, and the benefits gardening can have to body and mind. From those who have succeeded, we have learned that making on-site food production possible at affordable housing development there is no formula or perfect approach. The key is to prioritize access to food, and get creative with the resources, space, and interest available.

Appendix A

Full List of Interviewees:

Interviewee	Position	Organization
Emily Koo	Manager of Community Building	West Elmwood Housing Development Corporation (WEHDC)
Ben Rosen	Real Estate Development Director	Skid Row Housing Trust
Francesca De La Rosa	Director of Policy and Strategic Alliances	Women Organizing Resources, Knowledge and Services (WORKS)
Tara Barauskas	Executive Director	Community Corporation Santa Monica
Lara Regus	Senior Vice President, Development	Abode Communities
Ami Pascual Spear	Regional Director of Philanthropy	Mercy Housing California
Daniel Huynh	Director of Real Estate	LA Family Housing
Ryan Lehman	Senior Project Manager	A Community of Friends
Jan Breidenbach	Adjunct Professor	University of Southern California and Occidental College

Appendix B

Full List of Interview Questions:

Have you ever considered implementing rooftop farming in one of your affordable housing developments?

- If yes, did you implement it?
- Why or why not?

Do you have any hesitations about including a green roof in an affordable housing development?

- If so, what are they?
- How could these doubts be resolved?

How are your affordable housing developments normally funded?

- 4 or 9% Tax credits?
- Loans?
- Grants/fundraising?
- How has CRA disappearance impacted your funding?

What elements of your design, services, or amenities make your developments competitive?

Has the design of existing developments addressed any of the following issues:

- passive heating and cooling?
- urban heat island effect?
- storm water runoff & drainage?
- food accessibility?
- If yes, in what ways has the design of your existing developments addressed any or all of these issues?

What are the top concerns of an affordable housing developer in Los Angeles?

- Why are they your top concerns?
- How have your developments addressed them?

Do your developments have any elements of programming for the residents?

- If so, how has the participation of residents been?
- Are the residents involved in program decisions in any way?
- Do any of these programs involve food access? (ex: cooking class, community garden)

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