



# Sustainable Water Management for Urban Agriculture: Planting Justice, Oakland

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## Introduction

Urban agriculture is the practice of cultivating food crops and raising livestock in cities. It differs from traditional agriculture because it is integrated into densely populated areas and must address some unique challenges such as city ordinances and lack of arable land and open space. In the U.S., urban agriculture has become increasingly popular and is referred to in a variety of ways, e.g., urban gardening, urban homesteading, and edible landscaping.

Numerous community organizations are drawing on urban agriculture to address an array of environmental, social, and economic issues that include concerns about the current food system, food security, and “green job” creation. More specifically, although California is the largest food-producing state in the country (CDFA 2011), many residents in cities like Oakland and Richmond live in what are called “food deserts,” defined as places lacking access to fresh produce and food (UCANR and UC Small Farm Program 2008). The Bay Area is at the forefront of efforts to transform cities into food-producing landscapes. San Francisco and Oakland are adopting urban agriculture as a permanent component of their City’s General Plan.

At the same time, California recently passed the Water Conservation Act of 2009 (Senate Bill x7-7), which requires the state to “achieve a 20% reduction in urban per capita water use ...by December 31, 2020.” Outdoor irrigation accounts for approximately 60% of urban water consumption in California (Gleick et al. 2003) and therefore reducing inefficient outdoor use is a key component of many strategies to reduce urban water use. Moreover, municipal water supplies are typically much more expensive than agricultural water supplies and also may be more energy-intensive, as municipal water has been treated to drinking water standards. Thus, efficient use of municipal water supplies can have multiple benefits from helping water agencies to meet state water conservation and greenhouse gas reduction targets to reducing costs to water users. This case study reviews efforts to incorporate water-use efficiency and conservation practices into urban agriculture and describes how one organization in Oakland is utilizing permaculture techniques to address food justice, economic justice, and social justice issues.

## Background

This case study explores various water-efficient practices associated with urban agriculture, and highlights Planting Justice, an organization that incorporates principles of small-scale, sustainable food production with food justice and economic justice efforts. Planting Justice brings community members together to create “energy- and water-efficient gardens that

demonstrate how it is possible to grow a complete nutritional diet...right where 80% of U.S. residents live: in the city” (Planting Justice 2011).

Urban agriculture faces unique challenges, including typically higher costs for land and water (as most urban farms utilize municipal water supplies) and smaller growing areas that are frequently in close proximity to homes and businesses. Thus, much of the urban agriculture movement is focused on practices that conserve resources and minimize inputs, particularly those that could be toxic such as synthetic herbicides and pesticides. There are a variety of water efficient practices that have been incorporated into the urban agriculture movement, including water harvesting, water reuse, and improved irrigation, which will each be described below.

A growing number of organizations are utilizing urban agriculture as a tool to address concerns surrounding inequitable food access, job security, and environmental injustices in low-income communities and communities of color. Urban agriculture combined with permaculture principles is an approach to tackling concerns about human well-being and environmental protection which Environmental Justice, Food Justice, and Economic Justice movements aim to resolve. The guiding principles of Environmental Justice uphold the fundamental right of every person to a clean and healthy environment – defined as the space where individuals *eat, work, and play* – and equal access to environmental resources, decision making, and protection from environmental inequalities. Food Justice seeks to ensure that the benefits and risks of where, what, and how food is grown, produced, transported, distributed, accessed, and eaten are shared fairly (Gottlieb & Joshi 2010). Economic Justice seeks to diminish existing economic disparities. For example, in 2011 California’s unemployment rate among communities of color was almost double the statewide average (California Labor Market Review 2011).

## Planting Justice

Planting Justice is a non-profit organization based in Oakland, California. The goals of Planting Justice are to provide disadvantaged urban populations with a means to grow healthy food and maintain energy- and water-efficient homesteads in urban spaces. The organization is committed to the tenets of food justice, economic justice, and environmental justice. They do so by making edible landscaping and permaculture accessible. Permaculture, a term coined in 1974 by Australian Ecologists Bill Mollison and David Holmgren, refers to the concept of adopting “permanent agriculture” to promote sustainable food production systems. It is an evolving integrated design system that mimics the “patterns and relationships found in nature” while implementing techniques used for centuries by communities providing for their basic needs (Mollison & Holmgren 1974, Copeman 2008). Although permaculture techniques have generally been used in rural areas, Mollison and Holmgren stressed the potential of permaculture in urban settings since permaculture design is based on principles of small-scale, sustainable food production (Mollison and Holmgren, 1 & 6). Additionally, permaculture stresses the reduction of synthetic inputs (such as pesticides and fertilizers) and conservation of resources (such as water).

Planting Justice is composed of several programs providing education and assistance to urban residents who wish to grow food in their individual homes and in public spaces. Programs include:

- Grassroots canvassing—a door-to-door community outreach system to educate city dwellers about local food production, urban food forest design, and installation.
- Transforming backyards and open spaces into affordable food-producing gardens in food desert communities.
- Green job creation—locals receive training in permaculture and urban farming and then are able to oversee future projects. Just this year they employed five individuals who were trained in their programs with a starting salary of \$17.50/hour, three from San Quentin Prison and two from local high schools.
- Food justice education— teaching classes on agriculture and food access issues. Planting Justice provides classes at local schools, community centers, and San Quentin Prison, including:
  - Explore College Prep Afterschool Program, Oakland;
  - Food Justice and Culinary Arts Education Program, Mandela High School, East Oakland;
  - Urban Permaculture and Organic Food Production course, San Quentin State Prison;
  - Keller Plaza Community Garden and weekly education workshops, North Oakland.

Planting Justice supplies underserved communities in Oakland with the knowledge and practical skills necessary to sustainably produce a portion of their food. According to co-founder Gavin Raders: “Figuring out how to do that took a lot of thought. The question was how to start this work without relying on foundations [for grant funding]. If foundations don’t have the money, then you don’t have the jobs and you don’t have the project.” The organization has opted to build what it calls a “regenerative social-change model” that allows it to fund itself through a for-profit effort (Planting Justice 2011). Through working with paying customers, profits are re-invested into their not-for-profit endeavors. Planting Justice’s economic model has allowed for the creation of 86 urban gardens (33 subsidized) since 2009 in the cities of Oakland and Richmond. Furthermore, for every garden installed, an abundance of hands-on education is provided in the form of free workshops and school classes for youth and prison inmates. Individuals in food insecure communities are exposed to the benefits of harvesting their own food and learn about a variety of sustainable water practices, including water harvesting, water retention, and improved irrigation.

## **Sustainable Water Practices**

### **Water Harvesting – “Slow It, Sink It, Spread It”**

Water harvesting captures rainwater and runoff for later use, decreasing the use of often expensive and energy-intensive potable water. Catching and storing rainwater offers access to an abundance of water for irrigation purposes. In addition, greywater, or water that has not come in contact with sewage (e.g., water from sinks, showers, and washing machines) can often be reused for landscapes.

## Rainwater Harvesting

Rain provides water at no cost for various uses, including irrigation. The purpose of rainwater harvesting is to retain as much water on site as possible, slowing runoff to have it “perform as many functions as possible before it leaves” (Gavin Raders, personal communication). A rooftop can provide an abundance of rainwater; rainwater capture presents great potential for water savings, preventing runoff and reducing the reliance on municipal water.

There are four main components to rooftop rainwater harvesting systems: 1) a rooftop – the catchment area; 2) a gutter downspout – to divert the water to storage (Figure 1); 3) rain barrels or cisterns – to store the water (Figure 2); 4) a distribution method – to redirect water from storage to the landscape. When it rains, the water that would otherwise run off into storm sewers is diverted into a cistern (Figure 1). A metal mesh is used to strain any debris that may get into the tanks. The clean rainwater can then be distributed by various mechanisms into the landscape via a simple hose, a drip irrigation system, channels, pumps, etc. (Waterfall p. 9).



**Figure 1. Rainwater catchment system installed by Planting Justice in Oakland, Calif.**

Source: J. Nolasco



**Figure 2. 2,500 gallon cistern storing water from roof in Figure 1**

Source: J. Nolasco

In order to reduce energy use, it is important to observe the landscape to install a rainwater catchment system that takes advantage of the landscape’s slope and gravity. For instance, a flat plot cistern can be elevated so that the distribution of water is gravity-fed (Figure 2). Planting Justice has installed two large rainwater catchment storage systems that store up to 3000 gallons of water. The following formula calculates the potential volume of rainwater that can be collected from a catchment area such as a roof:

### Calculating Average Annual Rainfall Volumes

$$\text{CATCHMENT AREA (ft}^2\text{)} \times \text{AVERAGE RAINFALL (ft)} \times 7.48 \text{ (gal/ft}^3\text{)} = \text{TOTAL RAINWATER (gal)}$$

#### EXAMPLE:

CATCHMENT AREA: 1,500 ft<sup>2</sup> roof

AVERAGE ANNUAL RAINFALL: 24 inches = 2ft

$$1,500 \text{ ft}^2 \times 2 \text{ ft} \times 7.48 \text{ gal/ft}^3 = 22,440 \text{ gal}$$

TO CALCULATE AVERAGE RAINFALL FOR A SPECIFIC RAIN EVENT, SUBSTITUTE THE NUMBER FOR AVERAGE ANNUAL RAINFALL WITH THE AMOUNT FROM A GIVEN RAIN.

Figure 3. Equation to calculate the average annual rainfall volume for a particular catchment or surface area

Source: Harvestingrainwater.com

### Greywater Harvesting

Greywater, defined slightly differently in different parts of the world, generally refers to the wastewater generated from household uses like bathing and washing clothes. This wastewater is distinguished from more heavily contaminated “black water,” or sewage, from toilets. In many utility systems around the world, greywater is combined with sewage in a single domestic wastewater stream (Allen et al. 2009). Yet greywater can be of far higher quality than sewage because of its low level of contamination and higher potential for reuse. When greywater is reused either onsite or nearby, it can reduce the demand for new water supply.

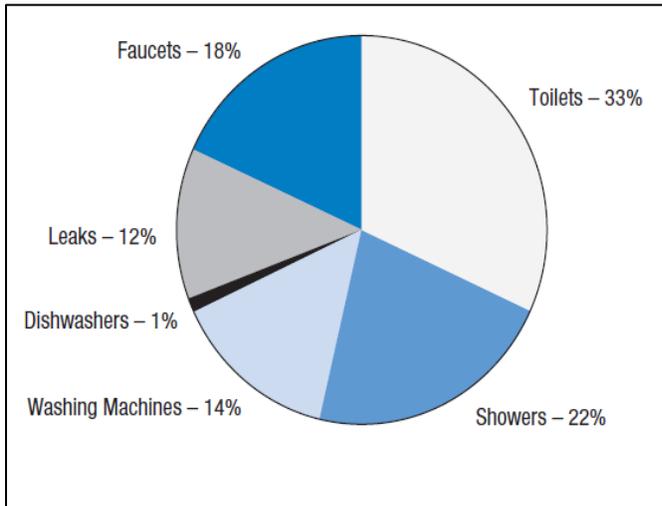


Figure 4. Estimated indoor water use - California (2000)

Source: Gleick et al. 2003

A greywater system captures water that has been lightly used, but has not come into contact with high levels of contamination, e.g., sewage or food waste. Water that has been used once in a shower, clothes washing machine, or bathroom sink can be diverted for outdoor irrigation through relatively simple tweaks in basic plumbing. The demand of potable water for irrigation and the streams of wastewater produced by the shower, washing machine, and sink are reduced. Possible public health concerns can be mitigated when greywater systems are designed and implemented properly. For example, some greywater-to-landscape systems utilize bio-filters or contained areas with water-loving plants to filter water before it enters an irrigation system (Figure 5).



**Figure 5. Recycled bathtub bio-filter for greywater system connected to drip, Beegril Gardens, Oakland, Calif.**

Source: J. Nolasco

In 2010, the state of California added the Graywater Standard to the California Plumbing Code, making it easier for residents to reuse greywater. The new standard allows for simple greywater systems be installed without a costly permit. With training from Greywater Action, a non-profit organization that provides homeowner education and hands-on workshops along with a five-day “greywater installer’s course,” Planting Justice has diverted greywater to landscapes in nine gardens across Alameda County. The completed laundry-to-landscape systems re-use approximately 3,000-6,000 gallons of water per year; while the shower-to-landscape systems recycle and save approximately 5,000-7,000 gallons of water per person using the shower per year (Gavin Raders, personal communication). These estimates are based on two loads of laundry per week and one five-to-ten-minute shower per person per day.

## Water Retention

High soil organic matter enhances its productivity and permeability, resulting in increased water infiltration and retention. Here, we review several landscaping techniques and topographical features that improve water infiltration and retention: sheet mulching, basins, and swales. These permaculture techniques help diminish the amount of runoff going into storm drains and improve soil condition.

## Sheet Mulching

Soil health and fertility are key for high crop yield. Sheet mulching, a composting technique used to amend soil and increase water retention, improves soil structure by providing an abundance of nutrients. The technique involves composting organic materials rich in nitrogen and carbon that establish beneficial nutrient cycling and microorganism habitat within the soil (Elevitch & Wilkinson 1998). Sheet mulching is accomplished by creating a landscape “lasagna;” the layers are made up of cardboard, compost, and mulch (Figure 6) (Kaplan & Blume 2011 p. 62).

The organic matter decomposes, providing a food source that boosts soil productivity and microorganism activity. For example, worms act as soil aerators and nutrient providers, by way of eating through the organic matter (Elevitch & Wilkinson 1998; Kaplan & Blume 2011). The natural processes promoted by sheet mulching can eliminate the need for chemical fertilizers and pesticides.

In addition, sheet mulching decreases water evaporation. The “lasagna” forms a protective layer between the soil and the sun reducing evaporation, and further water runoff is slowed. This results in greater ability of the soil to retain available moisture and diminishes the need to provide excess irrigation water (Elevitch & Wilkinson 1998). Planting Justice incorporates this technique on all of their garden projects because of its essential benefits for plants and water collection.

### Swales and Basins

The formation of swales and basins facilitates water capture. Close examination of a site’s topography is necessary to collect water in low-lying areas. Forming swales and basins requires digging trenches and, in some cases, molding raised beds (berms) along the contour of the landscape. When it rains, water is captured in the trenches and remains on the surface for a few hours while it slowly percolates into the soil (Figure 7). Swales and basins provide a less complex system for rainwater capture and are ideally dug between garden beds or trees. The harvested water is filtered as it seeps into the soil. Plants and trees along the swales and basins benefit because soil moisture is enhanced and the groundwater on the site is recharged, increasing productivity. Swales and basins slow rainwater runoff and store water on-site temporarily. Planting Justice has designed and incorporated approximately ten swales and basins for several of their garden installations.



**Figure 6. Sheet mulching for garden transformation by Planting Justice**

Source: Planting Justice photostream,  
<http://www.flickr.com/photos/plantingjustice/>



**Figure 7. Swale design and implementation by Planting Justice**

Source: Planting Justice photostream  
<http://www.flickr.com/photos/plantingjustice/>

Current popular landscape irrigation practices tend to consume excess water, but multiple water-saving systems are on the market today. Drip systems and weather-based measuring devices for example can significantly improve watering efficiency by matching water quantity to plant need. Proper design and maintenance are necessary for best watering results.

## Drip Irrigation

Drip irrigation, also known as micro- and trickle-irrigation, is characterized by the slow and accurate application of water to plants. Drip systems are composed of a network of tubes and emitters that allow water to drip straight to plant roots at low volumes (Lazarova & Bahri 2005). Drip systems can be connected to cisterns and greywater diversion systems and include filtering mechanisms to keep debris from clogging the emitters. Potential irrigation efficiencies for drip systems are relatively high, ranging from 88-90% (Salas et al. 2006). They also consume approximately half as much water as sprinklers (RANA Irrigation Services). Micro-irrigation emits water at gallons per hour versus other watering systems that discharge water at gallons per minute (EBMUD). Continual maintenance is important to achieve maximum water efficiency. This method of irrigation reduces water loss from canopy interception, wind drift, and evaporation (Lazarova & Bahri 2005) (Figure 8). Drip systems can be operated manually or with automatic scheduling controls. Planting Justice has installed drip irrigation mechanisms in approximately half of their 86 garden transformations. They have put 40 drip watering systems in place, substantially reducing over watering of plants.



**Figure 8. Drip irrigation system, Merritt College Urban Garden, Oakland, Calif.** Source: J. Nolasco

## Weather-Based Irrigation

It is important to irrigate based on plant water needs. The California Irrigation Management Information System (CIMIS) provides real-time information on crop water needs statewide that can be used to determine when to water and how much water to provide. In addition, there are new weather-based irrigation controllers (WBICs) to manage watering. They can automatically control how much and how often water needs to be delivered according to local weather. WBIC's sense precipitation and high humidity and will automatically shut off irrigation systems.

## Benefits

Substantial amounts of potable water in cities are lost to evaporation and runoff due to a lack of water management. Implementing sustainable water practices in cities promotes reduced dependence of municipal water supply and infrastructure. More specifically, the methods of water retention and harvesting effectively decrease reliance on public water systems by

providing supplemental water for non-potable uses. Storing water and recycling lightly used wastewater for gardens curbs urban demand for freshwater resources adding to more self-sustaining communities.

The transformation of urban landscapes into sustainable edible gardens creates what is known as a living sponge (Brand Landcaster). Soil is organically fertilized improving its health and permeability allowing substantial water to infiltrate. As water percolates into the soil, it goes through a natural cleansing process and recharges the groundwater in the garden. The slowing and retention of water on site promotes greater root growth, improving plants' drought tolerance (Waterfall article); targeting the water distribution and amount promotes higher crop yields. Such water practices result in supplemental water, increased water infiltration and soil moisture, reduction of polluted runoff into storm drains, and increased crop yields from nutrient-rich soil and the appropriate water needs.

## Challenges

Although the systems discussed in this paper have potential to conserve water and improve urban environments, there are challenges to sustainable water management for urban agriculture. Urban water use metrics and data collection are imperative to quantify actual use and inefficiencies from public and private consumers. A lack of measurement and data collection, especially for outdoor water use, leads to little ability to quantify the savings associated with sustainable water management. Most of the urban gardens visited during this research employ smart water practices, yet actual water consumption amounts remain unknown, especially in community, school, and public land projects. Regular maintenance of water harvesting and irrigation systems is also necessary to achieve maximum efficiency. Rainwater catchment, greywater, and drip systems are sensitive to debris collection and leaks, and hence require appropriate knowledge and upkeep. Moreover, while the practices vary in complexity, the costs associated with implementation, training, and upkeep of larger and more complex rainwater, greywater, and drip systems are relatively high. While the cost for the installations provided by Planting Justice (\$2,000 - \$8,000) is less than conventional cost for landscaping, the service at full price is still not affordable for most low-income individuals. The organization has managed to implement an economic system which effectively allows them to subsidize gardens at sliding scales (for every 2.7 paid projects they are able to subsidize one residential or community garden). Some of those gardens have come at no cost and others at half the price, depending on financial need. In comparison to community gardens, two paid and 12 subsidized, residential paid gardens outnumber subsidized gardens. Over 60 edible landscapes have been created for full-paying customers to date, but only 11 have been subsidized. It is important to make edible landscaping affordable and a permanent part of urban dwelling.

While urban agriculture is gaining momentum in the San Francisco Bay Area, there are still disconnects. For example, there is little overlap between food justice organizations and the growing communities of permaculturalists, urban homesteaders, urban farmers, and urban gardeners. For individuals who face poverty and have no agricultural background, "growing food is just not high on the radar, they don't make the connection as readily" as individuals who engage in it as part of a growing movement or those who have it embedded in their culture (Gavin Raders, personal communication). Additionally, many "immigrant communities have it

[urban agriculture] as a living part of their culture” (Gavin Raders, personal communication), yet their presence is lacking in the growing movement. Planting Justice is one of few examples that integrates sustainable urban agriculture techniques with a focus on food access, justice, jobs, and reentry issues. Further, the dialogue about urban agriculture needs to be synthesized and become more inclusive of all urban communities in order to achieve urban environmental, social, and economic goals. Implementing specific guidelines and providing adequate resources for urban agriculture and water management are necessary to set a precedent and produce self-sustaining cities.

## Conclusion

California is the leading agricultural producer in the U.S. (CDFA 2011). It also maintains the largest population in the country, and according to the U.S. Census Bureau, it is expected to grow 18% by 2030 (U.S. Census Bureau 2010). The concentration of population growth is in cities; thus as population expands, meeting urban water and food demands in the future may strain current public water systems and agricultural producers. Sustainable water management in cities is imperative to mitigate loss and ensure an adequate supply of finite resources. Water management practices such as rainwater harvesting, greywater-to-landscape diversion, sheet mulching, swales and basins, and controlled drip irrigation systems are ecologically sound and have proven to conserve considerable amounts of water. While concrete data about California urban water use is lacking, organizations like Planting Justice promote the efficient use of water and implement best practices for landscapes. They continuously demonstrate how such methods can be made easily accessible to urban populations via education and training. Their program has reformed many non-producing, water-intensive landscapes into abundant food-producing, water-efficient gardens. Planting Justice achieves such results by matching water amount and quality to plant needs, conserving soil moisture, and decreasing dependence on high-quality potable water—successfully generating water and energy savings as well as environmental and nutrition education across Alameda County.

In addition to adding to water productivity, urban agriculture can be utilized as an alternative to the major dependence on current large-scale food production. Conventional agriculture may rely heavily on sources that are environmentally degrading and water intensive. Food processing and distribution is also energy- and water-exhaustive: for example, food travels up to 1,500 miles from farm to plate generating great amounts of greenhouse gas emissions (Green for All 2010). An average of 15.9% of California residents are food insecure despite the state’s ranking as the leading agricultural producer in the country (Coleman et al. 2011). Many low-income communities and communities of color like those of Oakland and Richmond tend to be gravely affected by inadequacies of the food system. It is in these places that urban agriculture can provide sustenance for people’s bodies and minds.

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