IOWA STATE UNIVERSITY
Extension and Outreach

Rainwater Harvesting for Homes and Community Gardens

Introduction

Rainwater harvesting (RWH) is a practice that collects rainfall from a rooftop or other structure to be stored and used later for irrigation or other beneficial uses. Capturing and reusing rainwater is a free source of relatively clean water that can help reduce stormwater runoff on your property, while positively contributing to environmental goals of your community or region. Getting started with a small system like a rain barrel can be expanded to larger storage cisterns and include automated irrigation, if desired. This publication provides a blueprint for capturing rainwater for small-scale, residential or community-based gardens, focusing on the safe and effective use for irrigation of flower beds or vegetable gardens.

Site Planning

Site planning for an RWH system should start with your local planning and zoning office to ensure permits and other requirements by regulatory agencies are followed. RWH systems can be installed in most climates, but consult local guidance and water policy regulations before doing so.

A water budget is an accounting of the monthly or weekly water needs during the growing season, compared to water available to be captured and stored. To start, determine how much water is needed to irrigate landscaping, trees, shrubs, or vegetable gardens. At this stage, you can also plan for future expansion of gardens or other vegetation that may have additional watering needs. Next, determine how much rainwater is available for collection and storage, which depends on your climate and seasonal rainfall patterns. This map (figure 1) shows average annual rainfall, or visit the US National Centers for Environmental Information, ncei-normals-mapper.rcc-acis.org, to build average monthly precipitation maps of your region or state . By comparing the monthly water available to water needed for irrigation, you can determine the deficit and size your collection system accordingly.

Rooftops of existing buildings are the most common surfaces used for collecting rainwater, since gutters and downspouts make these easy to retrofit into an RWH system. However, care must be taken to avoid overflow that could damage basements or foundations. It's also important to consider aesthetics of the system, including views to and from the site. Many options exist to enhance the aesthetics, including spray painting gutters or pipes to match building exterior or turning the rain barrel into a work of art. Lastly, it is important to consider location of any buried on-site utilities, such as water or gas lines. Most communities have a "One Call" service to locate these free of charge.

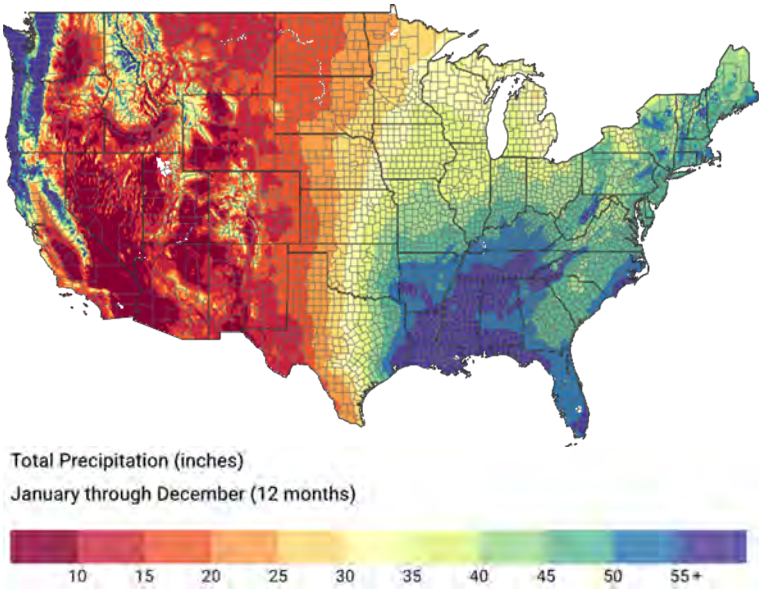

Figure 1: Three-decade averages of annual precipitation based on data gridded US climate normal dataset from the National Centers for Environmental Information (NCEI 2023).

System Components

RWH systems consist of six primary components:

1. Catchment surface: Rainwater that hits the rooftop of your home, shed, or shelter often is an easily accessible option for the catchment surface. The size will influence the possible water volume available for collection, and the rooftop material and debris, such as leaves, seeds, and animal waste, can affect the water quality.
2. Conveyance: Gutters collect water from the catchment surface and convey it through downspouts to be stored in the rain barrel or cistern. Filters, such as gutter guards and inline leaf catchers, should be used to minimize debris entering the storage tank.
3. Storage: Rain barrels typically hold 55 gallons, but cisterns come in a range of sizes and shapes. Creative solutions exist for repurposing tanks and connecting barrels in a series.
4. Treatment: Dark colored or covered rain barrels minimize light exposure and reduce algal growth. In addition to screens on gutters, a first flush diverter allows the first part of the rainfall to bypass the storage container, which often has higher concentrations of debris, bacteria, and other possible pollutants.
5. Overflow diversion: During large storms, rain barrels will only capture part of the rainwater running off the catchment surface. By directing the overflow to a bioswale or rain garden, that excess rainwater can soak into the ground, nurturing landscape plants and minimizing flooding.
6. Distribution: Elevating the cistern allows easier access to the outlet and increases the pressure at the end of the hose for watering. Connecting a two-way valve to the cistern's outlet provides flexibility for manual watering and automated irrigation systems.

Catchment Surface

Rainwater catchment areas include existing roofs on homes, garages, or storage sheds. Simple structures also can be installed to create a catchment surface while providing shade and a place for storage. The most ideal location for the RWH system is an existing downspout near the garden where the collected water will be used. This will minimize loss of pressure from the storage tank to the garden and improve access for hand watering. Most rooftops are suitable for capturing rainfall, but metal, plastic, clay tile, or concrete tile generate the cleanest water. Rainwater should not be harvested from roofs made of copper or untreated metal (such as galvanized roof, which can leach zinc), treated wood, or any material with lead-based paint. Common roofing materials such as asphalt shingles are suitable if these are in good condition.

Conveyance

RWH systems typically are tied into existing gutters and downspouts to direct rainwater to the cistern. Installation of screens or guards on the top of the gutters, mesh at the connections of the downspout to the cistern, and leaf catchers in line with the downspout all are effective ways of minimizing debris and contaminants from entering the cistern. If the downspout connection is fitted directly to the cistern, add a relief valve to allow pressure to stabilize.

Storage

Rain barrels or cisterns used to store the water are site-specific, with capacities ranging from 50 gallons to 1,000-plus gallons. The optimal size is best approximated by performing a water budget, including an estimate of average water supplied via rainfall and irrigation demand as described above. Supply is determined by the average monthly rainfall in your region and the catchment area. Although rooftops are impervious, evaporative loss and inefficiencies can reduce total volume by up to 15%.

Harvested rainwater (gallons) = catchment area (ft^2) × rainfall depth (inches) x 0.62 (conversion factor) x 0.85 (collection efficiency)

Multiple options exist for increasing available storage to accommodate supply, including connecting several smaller barrels in a series or using a larger cistern. Often multiple gutters and downspouts can be used to collect rainwater, and strategic placement can help the site function more effectively. It is important to lay out the site to maintain clear access to cistern components for maintenance, avoid long lengths of irrigation hoses/tubing, and avoid crossing sidewalks or other access paths. More details are provided for water distribution and overflow considerations in the following sections.

Figure 2: Rainwater harvesting system using an upcycled IBC tote covered with green waterproof nylon cover to minimize sunlight and algal growth. First flush diverter is circled in white to allow the first proportion of rooftop runoff to bypass the cistern.

Treatment

Algal growth in the cistern generally can be prevented by either covering the cistern with a weather-proof cover or using cisterns made of dark, opaque materials. This prevents sunlight from reaching the water and minimizes algal growth. In addition to the screens on gutters and downspouts, incorporating a first flush diverter (Figure 2) can further improve water quality. During dry periods, catchment areas can collect dust, debris, and animal waste. When it rains, these contaminants are concentrated in the initial flush of runoff. First flush diverters are designed to divert this runoff and can significantly reduce the level of debris, bacteria, and nutrients in the collected water. Diverters are designed to capture approximately 10 gallons for every 1,000 square feet of catchment surface. A float rises as water fills the chamber and bypasses the cistern. A slow release valve or small orifice at the bottom of the chamber ensures that the chamber empties and resets after each rain event.

Overflow Diversion

When the volume of water captured exceeds the amount of water used, it will overflow the rain barrel. The likelihood of overflow occurring depends on the local climate, water usage levels, depth of rainfall, and rain barrel size. Diverting this overflow to infiltrate into the soil away from building foundations is critically important. Small footprint rain gardens or bioswales can be a solution. These vegetated green stormwater practices include well-drained soils and vegetation to promote infiltration, and can include plants that provide additional aesthetic and ecological functions, such as providing pollinator habitat.

For sizing and installation, resources are available through Purdue Extension's Rainscaping Education Program (extension.purdue.edu/rainscaping/).

Distribution

Raising the cistern two to three feet above the ground surface provides access to the outlet spigot while increasing the pressure head of the water to aid in distribution to garden beds. Stable and structurally sound platforms can be constructed with treated lumber and cinder blocks. Irrigation can be done manually with a watering can or a hose connected to the outlet spigot. Alternatively, drip irrigation systems can be implemented, which can provide another layer of protection when using water for vegetable crops. Drip irrigation is a network of tubes and emitters of drip tape to deliver water straight to the plant at the roots. By watering at or below the soil surface, contact between the edible portions of the plant and potential bacteria or other contamination is minimized. Drip tape is intended for shorter duration use, needing to be replaced each season. Drip tubing can last multiple seasons, is generally more durable to accidental nicks with garden tools, and better suited for low pressure RWH systems.

Food Safety Considerations

Actions that minimize exposure risk to pathogens and other chemicals when using harvested rainwater fall into two categories: (1) strategies to minimize contamination of your collected water and (2) watering approaches to reduce contact with edible portions of the plant.

Minimize contamination of collected water.

1. Inspect and clean roof, gutters, and downspouts regularly and remove leaves and other debris.
2. Install screens to block leaves and large debris from entering the cistern.
3. Incorporate first-flush devices so initial flow of rainwater, which has higher pollutant and bacterial concentrations, bypasses the cistern.
4. Cover or paint the cistern to minimize sunlight, and therefore, algal growth.
5. Clean cistern with dilute bleach or vinegar solution before the start of each growing season.

Reduce contact with edible portions of the plant.

1. Install an irrigation system to drip water at the base of the plant or slightly under the surface.
2. Install a barrier such as a biodegradable plastic sheet to cover drip lines to provide additional protection for lower-growing crops such as leafy greens or summer squash.
3. When hand watering, water the soil at the base of the plant, not the leaves or fruit.
4. Water early in the morning to allow time for the plant surface to dry. This speeds up the destruction of plant and human pathogens by the sun, and it saves water.
5. If possible, use potable water for leafy greens, herbs, and other plants where the leaves are consumed.
6. Maximize the time between irrigation and harvest.
7. Wash all produce prior to consumption, and never wash with harvested water.

Table 1. Rainwater catchment system general maintenance.

Maintenance Activity	What Needs to Be Done?	When Does It Need to Be Done?
Clean downspout filter	Remove leaves and other debris that may be blocking mesh on downspout filter.	After every rain event.
Empty first flush diverter	Ensure water has emptied from the first flush diverter; remove the end cap or clear any sediment/debris from orifice opening and drain water into grass or rain garden.	After every rain event.

Table 2. Rainwater catchment system seasonal maintenance.

Maintenance Activity	What Needs to Be Done?	When Does It Need to Be Done?
Clean gutters	Detach rainwater catchment system from gutters. Remove dirt and debris from gutters and flush downspout with garden hose.	Spring/Winter
Clean rain barrel	Detach rain barrel and empty any remaining water. Rinse the interior. May need to scrub with a dilute solution of water and vinegar or bleach (1 cup to 5 gallons of water). Rinse barrel after scrubbing. Let dry. Check that spigot is functioning and reconnect.	Spring/Winter

Maintenance

Consistent maintenance is key to a well-functioning system. This should be done both at the start and end of each growing season, and periodically during operation. Keeping a clean RWH system helps maintain high quality water. It is important to clean the RWH system prior to collecting rainwater at the start of the growing season and at the end of the season during winterization to maintain a well-functioning system. This involves mixing a dilute bleach or vinegar solution, using it to rinse the main storage tank, and then allowing it to fully dry. It also is helpful to periodically inspect the system to keep catchment surfaces and gutters free of debris.

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Resources

American Rainwater Catchment System Association (ARCSA)-Rainwater Harvesting arcsa.org

Iowa State University Extension and Outreach publication - Rain Gardens: Filtering and Recycling Rain Water store.extension.iastate.edu/product/Rain-Gardens-Filtering-and-Recycling-Rain-Water

Iowa Stormwater Partnership - Rainscaping Iowa iowastormwater.org/campaigns/rainscaping

Purdue University Extension - Rainscaping Education Program extension.purdue.edu/rainscaping

Penn State Extension-Urban and Residential Stormwater extension.psu.edu/water/urban-and-residential-stormwater

Texas A&M Agrilife Extension-Rainwater Harvesting rainwaterharvesting.tamu.edu/