New York State
Rainwater Harvesting Guide

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Environmental
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New York State Rainwater Harvesting Guide 2015

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What is Rainwater Harvesting?

According to the National Conference of State Legislatures, rainwater harvesting is “the act of utilizing a collection system to use rainwater for outdoor uses, plumbing, and in some cases, consumption” (NCSL 2013). While there are laws pertaining to rainwater harvesting in some states, New York is not one of them. Rainwater harvesting captures, diverts, and stores rainwater for later use. The method of harvesting rainwater is an innovative approach to use water more efficiently, resulting in monetary savings.

Why Participate in Rainwater Harvesting?

Even with low rainfall averages, one can save money by efficiently collecting and storing rainwater for irrigation for many aspects of the landscape. Rainwater harvesting can also be an easy solution to minimize harmful environmental effects that could be occurring on a property.

Benefits of Rainwater Harvesting

- Decreased erosion from rainwater runoff, which can decrease agricultural productivity.
- Reduced charges on utility bills.
- Reduced runoff that could be carrying harmful contaminants such as fertilizer, sediments, or pesticides. This becomes especially important when on a farm or near a body of water.
- Rainwater can be used to clean machinery, provide drinking water for animals, wash out of pens and parlors, and supply water to irrigation systems.

Did you know? Many areas of New York State use salt to keep roads safe in the winter. However, this salt can infiltrate soil on a property and inhibit vegetation growth. Rainwater, however, is free of salts and minerals. When rainwater percolates into the soil it pushes the salt away from the root zones, promoting healthy root growth.

Rainwater harvesting systems can be very easy to create. This guide helps homeowners, farmers, and other users design and utilize a rainwater harvesting system that is right for them and their property.

Water Use and Supply Nationwide and in NYS

Water uses such as irrigation, public supply, and thermoelectric power account for 90 percent of the nation’s total water consumption (USGS,

2015). According to the U.S. Geological Survey, the estimated total water use for New York State in 2010 was 10.6 billion gallons per day.

New York State is rich in freshwater sources, as normal annual precipitation in most of state ranges from 30 to 50 inches (NOAA 2015). These sources provide drinking water, flood protection, and support "recreation, tourism, agriculture, fishing, power generation, and manufacturing" (NYSDEC, 2015). However, freshwater is not an unlimited resource, and water users are only increasing in New York (NYSDEC, 2015). Since water is so valuable, water conservation efforts and conservation programs have been developed throughout the state.

Before Installation

There are many factors to consider when choosing the right rainwater harvesting system that caters to a property owner's demands. Determining the right system in the beginning will save money and increase efficiency.

What Is the Primary Use of the Rainwater Harvesting System?

Collected rainwater may serve in various applications, including landscaping, in-home use, livestock, fire protection, stormwater management, and facility/equipment washing. Identifying water applications will guide system size and installation needs.

Consider the Following:

- Will the harvested rainwater be used immediately, or stored for later use?
- Will the system need to have high pressure to spray crops, or will a low pressure, dripping system be used to water the crops?
- Are the crops for consumption? If so, what water treatment system options are available?

How Much Rainwater Is Required?

Knowing how much water is currently used to water plants, clean, or provide drinking water for animals is important. Based on of a farm's water needs, a property owner can build an appropriate system. Annual water needs can be difficult to determine. However, the Penn State College of Agricultural Sciences has designed a guide that will assist in this analysis. The guide focuses on water uses for animals, irrigation systems, milk houses, and parlor and holding areas (Penn State Extension 2015).

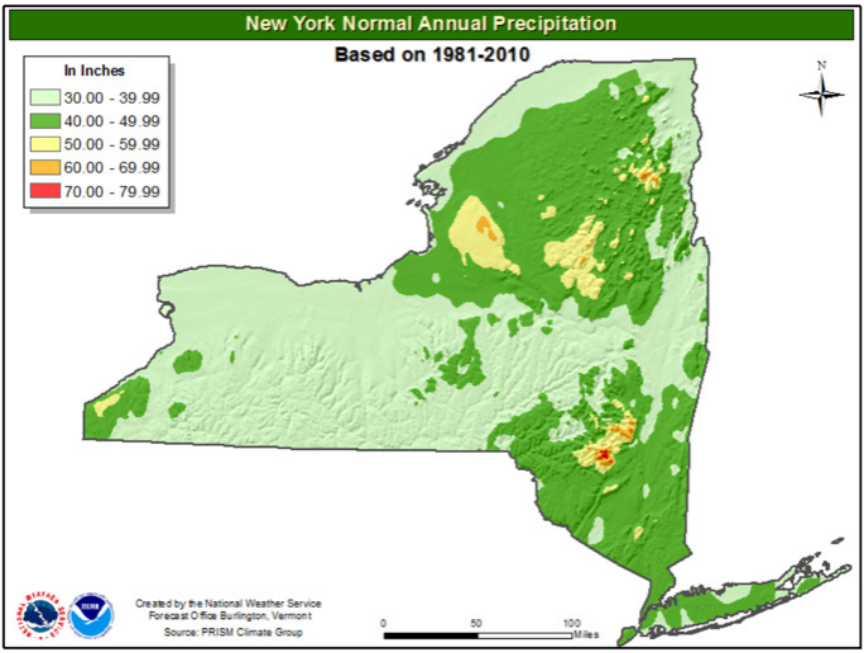
Estimated on-farm water use: _____ gallons

How Much Rainwater Can Be Collected?

Determining how much rainwater can be collected will give the user an idea of how to utilize it. The amount of rainwater that is available for use may affect the type and size of the system that a homeowner or farmer puts in place. Following these easy steps can help determine the amount of rainwater available for use in gallons.

Step 1

Locate the property where the rainwater harvesting system will be installed on the map below, created by the National Weather Service. Use the key to determine annual precipitation levels in that area.



Step 2

Next, determine the property's catchment area. For example, a roof with 30ft by 40ft dimensions will yield a catchment area of 1,200 square feet.

Step 3

Determine the runoff coefficient. Different types of materials allow for better runoff than others. If there are multiple locations on the property, different roof types will have an affect on the system. The roof's coefficient can be found in the table below.

Runoff Coefficients*		
Surface Type	**High**	**Low**
Roof		
Metal, gravel, asphalt shingle	0.95	0.75
Paving		
Concrete, ashpalt	0.95	0.70
Brick	0.85	0.70
Gravel	0.70	0.25
Soil		
Flat (2% or less), bare	0.75	0.20
Flat (2% or less), with vegetation	0.60	0.10
Lawns, Sandy Soil		
Flat (2% or less)	0.10	0.05
Average (2% to 7%)	0.15	0.10
Lawns, Heavy Soil		
Flat (2% or less)	0.17	0.13
Average (2% to 7%)	0.22	0.18

*Data obtained from: Haan, C.T., B.J. Barfield and J.C. Hayes, *Design Hydrology and Sedimentology for Small Catchments*, Academic Press; and Waterfall, P.H., 1998, *Harvesting Rainwater for Landscape Use*, Arizona Department of Water Resources.

Step 4

Calculate how much rainwater can be harvested on the property.

Rainwater Harvested (Gallons)	=	Average Inches of Rainfall Annually	x	0.623 Constant	x	Catchment Area (Square Feet)	x	Runoff Coefficient

Annual rainwater harvesting potential: _____ gallons

Efficiently Using Rainwater:

Investing in a rainwater harvesting system may not provide returns if there are leaking faucets and pipes. Leaks will result in unnecessary costs as homeowners end up buying or pumping more water. Homeowners and farmers should take precautions to prevent any water collected through the harvesting system from being wasted.

Follow These Steps to Increase Efficiency:

- Replace leaking hoses and faucets.
- Water crops in the morning or at night to reduce evaporation.
- When washing equipment or pens, use only as much as needed.
- Improve irrigation water use efficiency.

Components of a Rainwater Harvesting System

Source: Texas A&M Agrilife Extension Service

There are many parts that are crucial to a rainwater harvesting system. It is important that each part is constructed and placed appropriately to get the most out of the system. All rainwater harvesting systems need a catchment area, conveyance system, filter, storage, and distribution system (Innovative Water Solutions 2015).

Catchments

The catchment system makes first contact with the rainwater and directs it to the conveyance system. Catchments are most commonly roofs as they have a large surface area available with an adequate pitch to provide runoff. The catchment system will provide a "yield," or an amount of water per rainfall. Using materials that have a high yield will increase the system's ability to harvest.

Materials: Roofs are made from various materials, which affects the properties of the catchment area. Considering the material of the roof is most important when the rainwater harvesting system will be used for potable water. Metal roofs are best for this application as they easily shed contaminants. Additionally, metal roofs have one of the highest yields due to high runoff coefficient and low permeability. Less debris will build up, keeping the water cleaner (Pickett 2015).

*Important: Make sure to avoid wood shingles or metal flashing that contains lead. Harvest rainwater in this application can be harmful to crops and inappropriate as a potable water source.

Slope: A steeper slope on the roof will allow water to run off more quickly, cleaning the roof of containments. Less steep roofs will allow contaminants to sit on the roof longer, possibly causing problems for the

system (Texas A&M Agrilife Extension 2015a).

Conveyance Systems

From the catchment area, the water needs to make its way to the storage tank. This is done through the conveyance part of the rainwater harvesting system. The conveyance system is usually made up of a series of downspouts and gutters that divert the rainwater to the storage tank. There are two types of conveyance systems, dry and wet. Both dry and wet systems have two main factors to take into consideration, sizing and proper installation of gutters and downspouts.

Dry Systems: These systems are designed for the water to run directly from the catchment to the conveyance system, and then into the storage tank. The only time there is water in the dry conveyance system is when it is raining, avoiding the problem of stagnant water (Rain Harvesting 2015a).

Wet Systems: Wet systems have piping that runs from the catchment to below ground. The piping resurfaces when it reaches the storage tank above ground. This is a more popular solution in applications where the storage tank is not located next to the catchment area and/or the catchment area is relatively large. Farmers or property owners that wish to irrigate land that isn't adjacent to the catchment area would benefit from using this option. Stagnant water in the piping between rainfall occurrences is one disadvantage of this system (Rain Harvesting 2015b).

The Fix for Wet Systems

An in ground water diverter makes sure that the water is flushed out of the underground wet system, therefore converting the wet system to a dry system. This improves water quality by not allowing water to sit, and reduces the possibility of contaminates from entering the tank. Diverters are built underground and are out of sight. http://rainharvesting.com.au/product/in-ground-diverters/

Sizing: According to the Texas A&M Agrilife Extension, gutters should be sized to be able to handle a 100-year storm event, meaning that a storm of that magnitude will have a one percent chance of happening every year. A gutter used as part of a conveyance system should be no smaller than five inches wide. Downspout size must be calculated. One square inch of a downspout should be provided for every hundred feet of catchment area supplying that downspout. The formula to calculate downspout size is below (Texas A&M Agrilife Extension 2015).

Downspout Size = (Length (feet) x Width (feet) of catchment area)/100

Proper Installation: This is important in order to make sure that the conveyance system is safe and functions properly.

Take the following steps to ensure that the conveyence system functions properly (Texas A&M Agrilife Extension 2015a):
- Paint PVC pipe to avoid UV breakdown. This can improve to the aesthetic of the system if this is a concern.
- Make sure the gutters are sloped at least 1/16" per foot to allow for proper drainage. This is especially important during freezing New York winters to avoid ice buildup.
- Provide gutter hangers every foot to help resist snow weight.
- Use rounded gutter outlets to reduce the amount of debris buildup.
- The front of the gutter should be a ½ inch lower than the back. When collecting rainwater, there is a possibility for debris to splash against the building.

Filtration

Debris is likely to enter the conveyance system as a result of rainwater collection. There are ways to help prevent this, resulting in a cleaner, more efficient system. The first step is to install a leaf screen over the top of the downspout, preventing any large debris from entering. After the leaf filter is installed, the rainwater should pass through a device called a first flush diverter. The diverter stops contaminants from entering the rainwater tank. One 10-gallon diverter should be installed for every 1,000 square feet of catchment area. An inline sediment filter removes any sediment after the water exits the tank and before it reaches the outlet. Inline sediment filters are important when using drip line irrigation systems. If not removed, the sediment will clog the holes in the drip line (Rain Harvesting 2015c).

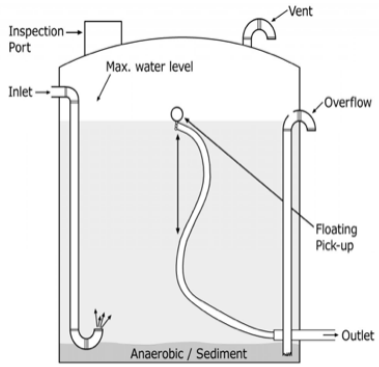
Storage

This is one of the most complicated but important steps when building a rainwater harvesting system. There are many factors to consider, such as safety, connections, above or below-ground, and tank material. Storage can be the most expensive part of a system, and so it is important to consider potential problems beforehand.

Safety: The goal of rainwater harvesting is to collect quality water that can be used for a multitude of agricultural practices and potentially for potable water. While the tank is holding water waiting to be used, steps should be taken to retain the quality of that water. The tank should not allow for light penetration, which will cause the growth of algae, thus tainting the water supply. The tank should be sealed except for any necessary inlets or outlets. This is important in keeping any insects or animals from entering the storage tank.

Connections: Every storage tank requires inlets and outlets in order to take in water, discharge water, and breathe (Texas A&M Agrilife Extension 2015b).

Inlet: The inlet is where rainwater enters the tank. It is important to have a calming inlet connected to the end of the inlet inside the tank. This is done to avoid any disruption of possible sediments on the bottom of the tank.



Source: Texas A&M Agrilife Extension Service

Outlet: The outlet is where the water drains from the tank. The outlet is connected to a floating object attached to a flexible tube off of the bottom of the tank. The bottom four inches of the tank should not be drained to avoid sediment drainage.

Overflow: Overflow releases excess water during a heavy rain.

Vent: The vent is important to stop a vacuum effect from occurring inside of the storage tank. Cover any openings with mesh so insects and other contaminants cannot enter the tank.

Inspection Port: Located at the top of the tank, the port allows for maintenance and inspection by the user.

Tank Materials: There are many different types of materials that can be used in tank construction. Each material has its advantages and disadvantages in cost, construction, and durability.

Above-Ground or Below-Ground: There is much to consider when deciding to place a tank above or below-ground. The advantages and disadvantages of each installation should be considered case-by-case based on the user's goals for rainwater harvesting.

Above-Ground: On a farm, there is usually not a problem with restricted space allowing for the placement of large storage tanks on the property. Many farms have multi-story buildings in the form of barns, garages, and holding areas. This allows for large tanks to be gravity fed to the tank from the catchment area. However, it is important to remember that in New York's winter climate, above-ground tanks need to be insulated and often drained for several months.

Advantages:
- Installation is less expensive.
- Maintenance and repair are much easier because of accessibility.
- It is easy to add another tank if necessary.
- Gravity fed tank.

Disadvantages:
- Subject to freeze-thaw cycles that make the system possibly unusable in the winter months.
- Heavy equipment, which can easily damage an above-ground tank.
- Sunlight can cause algal growth.
- May be considered an eyesore.

Below-Ground: This type of tank installation is often more common in large-scale operations. Underground tanks will be able to better handle the freeze-thaw cycles that New York experiences every year, thus allowing for possible year round use. An underground tank requires installment of pumps to get the water in the storage tank.

Advantages:
- Algal growth will not occur due to the absence of sunlight.
- The tank avoids weather conditions including freezing, as long as the tank is below the frost line.
- The ground temperature has a stable, cool temperature throughout the year, limiting bacterial growth.

Disadvantages:
- More expensive.
- Less accessible for maintenance.
- Soil shifts may cause a fracture to occur.
- The system will require a pump to move the water into the tank.

Distribution
The distribution system depends entirely on what the user wants to do with the water. Common applications for the rainwater include irrigation, washing of machinery and pens, drinking water for livestock, as well as any other application for water on the property. Distribution systems are designed case-by-case, as each farm will need the system to fulfill different requirements. Pumps, pressurized tanks, and control boxes are all optional, but will make the rainwater harvesting system more useful.

Pumps
When deciding on the type of distribution, pressure is an important factor to consider. Most rainwater harvesting systems present on farms need to be pressurized in order to perform at the level needed. Gravity

flow systems will not suffice for farming applications, unless only low pressure is needed for all water demands that have to be located at a lower level than the tank. Pumps will pressurize the system, expanding the potential rainwater usage, but for an increased price. When a system is pressurized, hoses, faucets, and irrigation systems can be used at any location on the farm, at any point. Pumps can either be located in-line with the discharge pipe, or submersed within the tank. Determining the size of the pump is based on the pressure and volume a user wants from the system. A good reference is that a typical indoor showerhead operates at 30psi and 2.5 gallons. A pump technician can advise users on the type of pump needed to meet agricultural needs.

Pressurized Tank

A pressurized tank is used to relieve the pump of a constant on/off cycle when using pressurized water from the system. Having a pump turn on and off repeatedly will reduce the lifespan of the pump. Pressurized tanks store water at pressure, and are refilled when depleted. These are useful when using only small amounts of water for jobs on the farm or at a residence.

Control Panels

The use of control panels will help monitor the system. There are many companies that sell control panels for rainwater harvesting (Texas A&M Agrilife Extension 2015b).

Making Rainwater Safe to Consume

If a user wants to use the system for drinking water or watering ready-to-eat crops, then ultraviolet (UV) sterilization is required. A UV unit will kill bacteria, pathogens, and viruses that could harm the consumer. Modern units work by allowing water to flow in between a UV light and a stainless steel tube. The UV light is wrapped in a quartz sleeve to protect the bulb from water, but still allows all of the UV energy to be transferred to the water. The water has to be free of sediments so shadowing of the UV light can be avoided. Shadowing could potentially cause the UV light to miss some of the contaminants. Using a carbon filter before the UV treatment will get rid of unfavorable smells and tastes. Using UV is only necessary if the water is going to be used for consumption or irrigation of ready-to-eat crops. There are many of applications for rainwater harvesting that don't require the use of a UV light (Conservation Technology 2015).

Freezing Conditions and Rainwater Harvesting

New York State has a wide range of temperatures throughout its four seasons. Even during the freezing winter months, rainwater harvesting systems still collect enough water to benefit system owners. When freezing temperatures do occur, certain precautions need to be taken in order to protect the system (The Watershed 2015).

Tanks: The tank should be emptied unless it is installed in a way to stop freezing from occurring. The tank can be placed underground below the frost line, reducing the risk of freezing. An aerator can be added to the tank to make sure there is movement in the water, preventing the water from settling or freezing. A heat pump can also be used to deter freezing as well.

Conveyance System: Make sure that the conveyance system has the proper slope to ensure there is never any sitting water in the gutters. This will cause a buildup of ice and place strain on the system.

Pump: Like the tank, the pump must either be winterized or placed below the frost line like the tank. Having an in-tank, submersible pump, is an advantage when freezing occurs. The water in the tank should not freeze, thus acting as protection for the pump.

Distribution: All distribution systems need to be insulated from freezing temperatures if not placed underground and below the frost line. If this is not possible, the distribution system should be drained during the freezing months to avoid damage.

Maintenance

It is important to take care of the rainwater harvesting system to maintain its efficiency and effectiveness. This is easy to do, and should be done before each rain season and after periods of heavy rainfall. Proper maintenance will ensure that the user is harvesting the most rain per rainfall.

Maintenance List

- Removal of any debris build up in the gutters and downspouts.
- Clean out all of filters periodically. This is important for systems using drip irrigation and/or rainwater for potable water.
- Flushing of the storage tank bottom to get rid of sediment buildup.
- Checking for leaks throughout the system and repair accordingly.

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