Rainwater Harvesting for the Home and Farm

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Introduction

Water use is an important issue in the west, and many people are interested in learning how they can use this resource more efficiently. While rain harvesting isn't going to solve all of our water use issues, it certainly is an impressive and effective way for individuals to take advantage of the surprisingly large amount of water that rolls off of their roofs every year. It may shock some people to find out just how much water their roofs are capable of collecting. For example, on average Ephraim receives 5.33 inches of rain from April to September.[1] With this amount of precipitation a roof that is only 1,000 square ft. (25 ft. long and 40 ft. wide) is capable of collecting 3,322 gallons of rain over the course of that time. That is roughly equivalent to sixty 55 gallon drums of water which is enough water to grow a decent sized garden. This fact sheet will cover the basic components of a rain harvesting system, Utah's laws for rain harvesting, how to estimate the volume of water storage you will need, ideas for increasing water pressure in your system, as well as tips and insights for building a rain harvesting system.

Basic Components

Although rain harvesting systems can vary both in terms of style and complexity, the basic components are relatively simple. They are:

- **Catchment area:** Intercepts the rain water and directs it toward the gutter system. This will most likely be the roof of a house, garage or other building.
- **Gutter System & Downspouts:** Catch the water draining off of the catchment area and channels it into the storage containers. If the roof of your house is your catchment area, the gutter system may already be in place, and you will only have to modify the downspout so that it channels the water into your storage containers. If you are installing your rain harvesting system on a building that doesn't already have a gutter system in place, then you can either buy a standard gutter system or you can get creative and build it from whatever you have lying around. For example, in Sanpete County Extension, we used 6 inch PVC pipe cut in half to build the gutters on our turkey barn.

Top view of 6-inch PVC pipe gutter system attached to shed roof catchment area & side view of water storage container with PVC gutter and downspout.

• **Storage Containers:** Hold the water until it is ready to be used. Make sure that your containers block out sunlight so you don't get algae growth inside them. Most people choose to use plastic containers such as 55 gallon drums or 275 gallon IBC totes because they are easy to modify and relatively lightweight, but just about anything that can hold water will do the job. You can save money by purchasing used containers, however you need to make sure that they weren't previously storing dangerous chemicals.

• **Overflow:** Directs any water in excess of what the storage containers can hold out of the system and ideally to a place where it can be made useful. We attached a hose to our overflow so we can direct the excess water wherever we think it is needed most.

• **Sunken Earth Basin:** Catches the overflow in a sunken basin to hold and absorb the water for a designed landscaping plant community.

• **Delivery System:** Allows the water to flow out of the storage containers to where it is going to be used. Typically it will consist of a valve that is built into the bottom of the storage containers and a hose that attaches to that valve.

• **Filters:** Prevent the system from getting clogged with debris such as leaves, insects, and dirt. If there are trees nearby, you will definitely want to install a filter in the gutter at the point where it flows into the downspout. This will prevent the downspout from clogging. You will also need to remove the leaves from the gutter as needed. To prevent dirt and insects from ending up in your storage containers, place a filter at the bottom of the downspout. Chicken wire or something similar will work great to filter out leaves, and cheesecloth or any other fine material which readily allows the passage of water but not solid objects will filter out the smaller debris.

Once again, these are the basic components of a rain harvesting system. Information regarding more complex systems can be found online.

Utah's Rain Harvesting Laws

It is important to be aware of Utah's laws concerning rain water harvesting. Luckily it is pretty simple:

• The maximum amount of water storage capacity for a parcel of land is 2500 gallons. Use of water is limited to the same parcel of land on which the water is collected and stored.

Gutter downspout with cloth screen to catch debris before entering the water storage container.

• You need to register your system only if one, or both, of the following conditions apply:
  - You have more than two collection containers.
  - You have a collection container that exceeds 100 gallons.

If your system meets either of these conditions, then you need to register it online. This free **registration** requires your name, address, and the total volume of containers.

General Design and Maintenance

1. Determine your roof's surface area by multiplying it's length by its width. Do not take into consideration the pitch or slope of your roof when figuring this out. In fact you do not need to get on your roof at all, just measure the length and width of your house standing on the ground (and it doesn't need to be exact!).

Length (ft.) X Width (ft.) = Surface Area (square ft.)
Ex. 30ft. X 50ft. = 1500 square ft. = Roof Surface Area

2. Decide how much water storage is ideal for your needs and your roof size. Obviously bigger roofs can collect more water than smaller roofs. But the main factor that determines how much water your system is capable of collecting is the amount of rainfall itself. The next formula will help you

know how much rain water (in gallons) will fall on your roof during any given amount of rainfall. So, if you wish to have enough storage space to collect all the water falling on your roof for a 1 inch rain event you will need much more storage than if you only wish to be able to capture all of the water from a 1/4 inch rain event.

3. Include the runoff coefficient to the equation. A portion of the rain water that reaches the catchment area will evaporate or be absorbed depending on the surface material. This can account for 5 to 20% of the total volume of rain water. To account for this we will multiply by 0.9 to get a more accurate total storage volume.

Multiply the roof's surface area by:

- 0.062 to find out how much rain (in gallons) will fall on your roof during a 1/10 inch rain event.
- 0.157 to find out how much rain (in gallons) will fall on your roof during a 1/4 inch rain event.
- 0.312 to find out how much rain (in gallons) will fall on your roof during a 1/2 inch rain event.
- 0.468 to find out how much rain (in gallons) will fall on your roof during a 3/4 inch rain event.
- 0.623 to find out how much rain (in gallons) will fall on your roof during a 1 inch rain event.

Surface Area (square ft.) X Conversion Factor X Runoff Coefficient = Amount of Rain (gallons)
Ex. 1500 square ft. X 0.157 X 0.09= 211.95 gallons of storage needed for a 1/4 inch rain event

So, in this example, if I want to collect and store all of the water that falls on my roof during a 1/4 inch rain event, I need at least 212 gallons of storage space. Any rain that falls in excess of a 1/4 inch will be forced to exit through the overflow as my storage will not be large enough to hold it.

Keep in mind that in Ephraim as an example, a 1 inch or greater rain event occurs a little less than once per year, a ½ inch to 1 inch rain event occurs 3-4 times/year, and a 1/5 inch – ½ inch rain event occurs about 9 times/year (Source: Ted Olson). Also, from the beginning of April to the end of September, Ephraim ;typically receives 5.33 inches of precipitation with the months of April, May, and September each receiving about 1 inch of rain while the months of June, July, and August each receive about 7/10 of an inch of rain (Source: USU Climate Center).

Ideas for Increasing Water Pressure in your System

Pressure is what forces water through the sprinklers or emitters in an irrigation system. Gardeners should note that their storage containers alone will not provide enough water pressure to allow them to use irrigation systems such as sprinklers or even most drip tapes. To overcome this problem, the gardener may either:

1. Use an irrigation system that can operate with extremely low water pressure,

2. Modify the rain harvesting system to increase water pressure, or

3. Use a combination of both strategies.

PVC drip irrigation systems are efficient, require very little water pressure, are adjustable and inexpensive, and may be a suitable irrigation system to use with a rain harvesting system. For more information on how to build these systems check out Jeff Banks PVC drip irrigation fact sheet (https://extension.usu.edu/files/publications/publication/Horticulture_Home_2008-02pr.pdf). Alternatively, there are two basic ways to increase water pressure in your system; you can add a water pump, or you can elevate the rain storage containers.

Elevation Gain Results in Greater Water Pessure

- For every foot of elevation that the storage containers are raised, the water pressure increases by 0.43 psi.
  - 1 ft. of elevation gain = 0.43 psi
  - 1 psi = 2.31 ft. of elevation

Tips for passively increasing water pressure in your rain harvesting and irrigation systems:

- Elevate storage containers.
- Connect all storage containers at the bottom (as opposed to the top like we did). This will reduce the rate at which the water level goes down in the storage tank(s) thereby reducing the rate at which the water pressure decreases.
- When building your irrigation system, install valves on all lateral lines so that the whole system doesn't have to be open when watering. You can then open and close the lateral irrigation lines to achieve the desired water pressure.

There are many ways to elevate your storage containers. Some people use cinderblocks, others build wooden frames, and others simply locate their storage containers at a higher point

of their property like on a hill to take advantage of the natural elevation difference on their land. If you choose to elevate you storage tank(s) keep in mind that water is heavy, and lots of water is very heavy. If building a structure make sure it is strong enough to support your tank when it is completely full. You can calculate this by multiplying the number of gallons your storage can hold by the weight of a single gallon of water (8.34 lbs.), and then by adding the weight of your storage tank(s) when they are empty.

Example: 220 gallons (total storage capacity) X 8.34 lbs. (weight of 1 gallon of water) = 1,835 lbs + weight of empty storage tanks = the weight your structure needs to support

Although water pumps can be expensive, they are fairly simple to install and use, and are an extremely effective way to increase water pressure.

Planning and Building your Rain Harvesting System

Once you know how much water storage you want in your system, you are ready to buy or build your system. Every house and yard is different, and you should adapt your system to fit your location and purposes. There are many "how to" videos on the internet which describe the process of building a rain harvesting system. Although we discussed the steps in this fact sheet, we highly recommended that you watch a couple of these videos to get a visual idea of what we are describing. This will also show you the variety of ways people build their rain harvesting systems. Once again be creative and do what makes sense for your needs, your budget, and your location.

You can also visit USU Extension's Utah Water Quality Rainwater Harvesting website for more information: **http://extension.usu.edu/waterquality/htm/urbanstormwater/rain-water-harvesting/**

Review of Steps:
1. Install gutter system. 2. Build elevation structure. 3. Modify storage container(s) so water can both flow in and out of them, as well as between them. 4. Modify downspout. 5. Install overflow. 6. Install filters. 7. Collect rain!

Useful Conversions

- 1 cubic ft. = approximately 7.48 gallons
- 1 inch = 1/12 of a foot
- 1 gallon = 8.34 lbs.
- 1 ft. elevation gain = 0.43 psi
- 2.31 ft. elevation gain = 1 psi

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Additional Resources

Lancaster, B. (2006). Water-harvesting calculations. Rainwater Harvesting for Drylands and Beyond. Retrieved from: **http://www.harvestingrainwater.com/rainwater-harvesting-inforesources/water-harvesting-calculations/**

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