

Rainfall Simulator Guidebook

“A cloak of loose, soft material, held to the Earth’s hard surface by gravity, is all that lies between life and lifelessness.”

- Wallace H. Fuller

UPDATED: INCLUDES TALKING POINTS, REMOTE CONTROL INFO

Soil texture, organic matter, root and vegetative systems affect soil and forage quality. Retaining rainwater for plant health and mitigating erosion through good grazing practices and selection of cover crops are goals for the producer. Demonstrating the effect of rainfall on various farming management soil samples help the producer better understand his land and its potential.

SC Forage and Grazing Lands Coalition

Version 3.0 of Rainfall Simulator Guidebook
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APPENDIX: REMOTE CONTROL UNIT INFO

Overview

IMPORTANT: This manual provides instructions for setting up and running a demonstration, but equally important are the talking points found on pages 20-24. If you are not familiar with them, please read before you perform your demonstration. They provide the 'why' behind what happens.

There are three rainfall simulator trailers -- one each in Laurens, Columbia and Florence. Each should contain equipment for a large free-standing rainfall simulation demonstration with up to five samples; a table-top unit; tools for collecting samples and clean-up materials.

Groups requesting a demonstration can go to SCrainSim.org to fill out a request form. There is also a link on the scforage.org website.



Except for the soil samples, the trailer has everything needed for a demonstration:

Water - can be provided at the site via hose from a host water source or from an onboard tank that can be filled prior to the demonstration.

Power - Used to run the sprayer, and onboard pumps if onboard water tank is needed. Can be provided by the host site via 120V supply or can run off onboard deep-cycle battery that is charged when hooked to a tow vehicle. A solar panel on top is used to trickle charge the battery.

General RFS trailer layout

Water runoff bottles are hung from ceiling. Buckets that can be used in sample preparation and disposal beneath

Trashcan and long-handle tool storage in bottom

Deep cycle battery behind door at bottom

Exterior 12VDC outlet for pump power if not using AC

FRONT

Storage for template used for cutting soil sample

Side door

Tabletop RFS unit components.

Storage for sample trays and accessories up top, general storage below

Water tank

Spray nozzle and extension storage

Dual pumps for use with water tank

Water hose storage

Interior 12VDC outlet

Sawzall in bag may be stored in shelf or on floor

RFS simulator frame and whiteboard storage

Important: Make note of items that are secured by strap during travel and be sure they are secured when the trailer is cleaned up after demonstration. Also, the shelf at the front of the trailer under the water runoff bottles is for stationary use only. There should be no items stored there during transport.

Summary of RFS demonstration steps

Prior to demonstration

1. Communicate with requestor to confirm time and details of demonstration, including availability of water and power. If no water is available at site, fill tank beforehand.
2. Confirm with RFS trailer owner that it is available and arrange time for pickup. Get keys from owner.
3. Confirm that tow vehicle and owner have insurance that cover trailer towing accidents and that the driver is experienced in towing trailers.
4. Confirm that all equipment and supplies are on the trailer. Make sure the Sawzall is charged.
5. Connect the trailer to a properly installed hitch, connect the safety chains (criss-cross them) and connect the trailer lights cable. Check operation of trailer brake lights and turn signals.
6. Collect samples if this is not going to be done on-site. Sometimes samples may be re-used, depending on the event and desired demonstration purpose.

At the demonstration site

1. Locate the trailer and vehicle in an area optimal for demonstration purposes -- in shade if available, near water, near power, etc.
2. Assemble the demonstration table and load sample trays, collecting samples if needed.
3. Hook up water supply, either from tank or local water supply. Make sure valve to feed nozzle is off. If using onboard water, turn on one or both pumps by tank, as needed.
4. Hook up power for nozzle motor, either from onboard DC power supply or local AC power. Be careful to not place power cords where they can get wet, causing a safety issue.
5. Apply power to test operation of nozzle before opening water valve to keep from spraying yourself and others.
6. Clear the area and open water valve. Apply power for a test run.
7. Make sure the spray covers all the sample trays fully.
8. Check runoff and water coverage. Adjust parts, water flow as needed.
9. Place rain gauges in two trays.
10. Make sure the demonstration area is neat and clean before the demo.

Gathering samples

A soil sample cutter template is provided on each RFS trailer so samples can be cut for the exact size and depth to fit the soil trays.

To demonstrate the effect of rainfall on loose soil without groundcover, samples can also simply be gathered by shovel.

It's ideal to have at least two people collect samples because of the weight of the template and soil.

To use the template cutter, place it over the desired area and press down until there is no play in the plate at the top.

This may be difficult in dense soils. If so, use one of the spades from the trailer to cut the earth around the edge of the template cutter.

To get the sample out of the ground, use the spade to dig around and beneath the template so there will be some excess when the template is removed. (See next page for an illustration).

With a partner's help, place the template and sample upside down in one of the buckets from the RFS trailer.

For dense samples, a handsaw or Sawzall on the RFS trailer can be used to slice the sample off with the edge of the overturned template cutter.



Gathering a sample - getting it in the pan

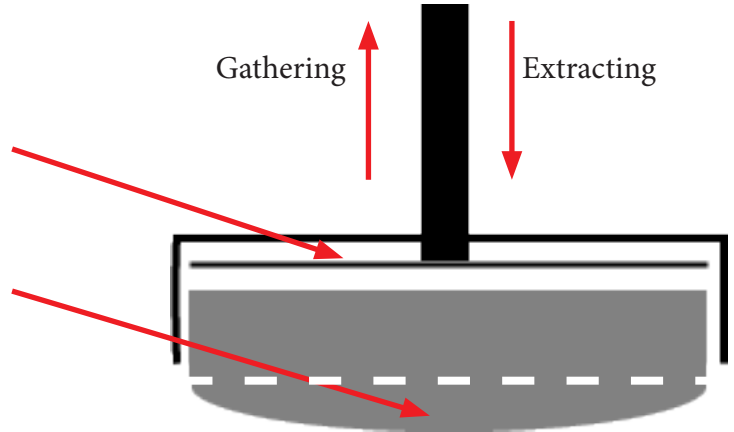
A side view of how the cutting template works.

Note that the inside plate should snug against the top when at the proper depth.

Note the rounded bottom produced by digging beneath with the spade. This is trimmed flat to the template when it is turned over.

The sample pan is then positioned over the sample, the template is flipped over, and the center post is used to push it out into the tray.

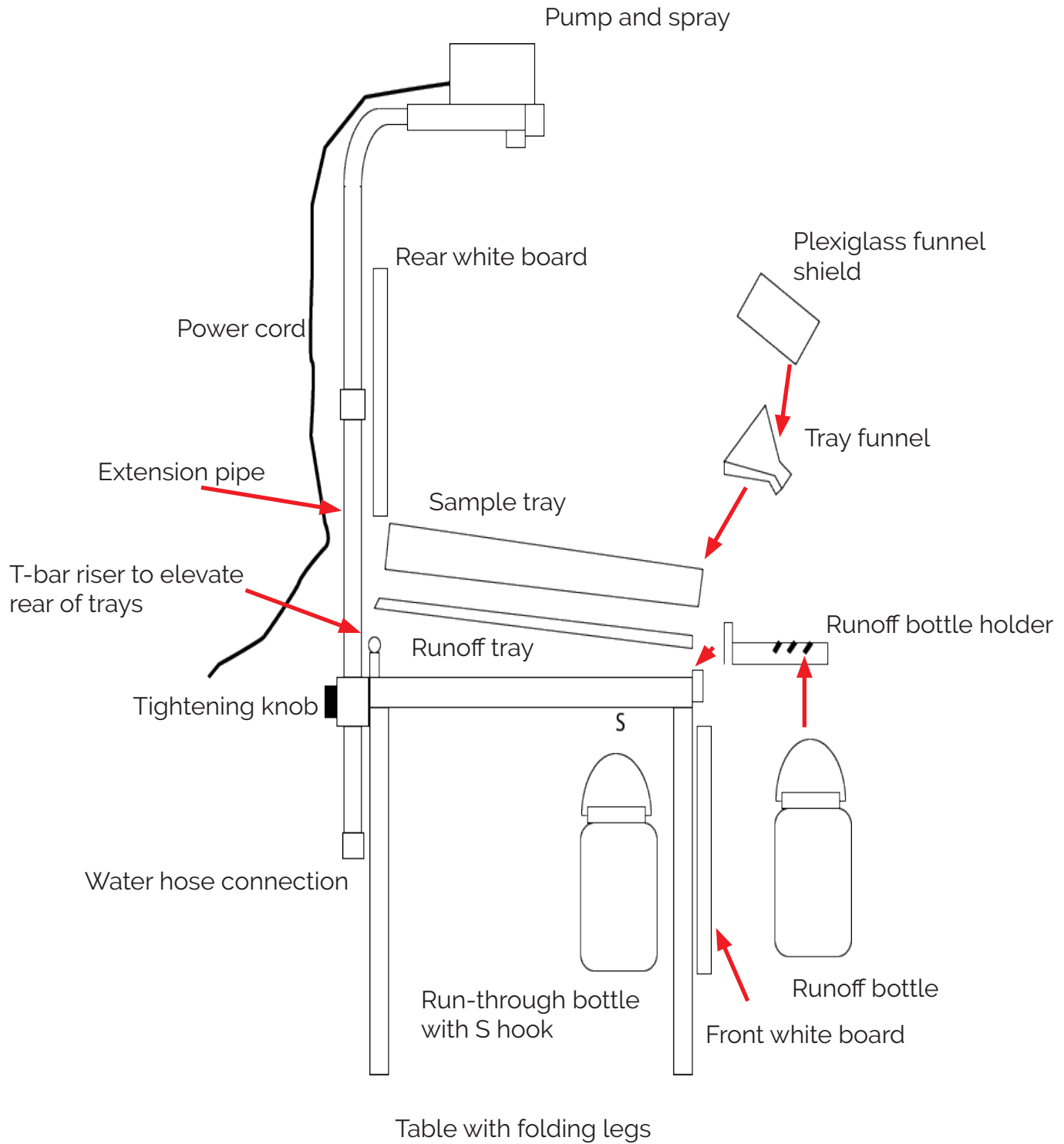
For demonstration purposes, loose soil or soil with some organic matter may be simply dug with spade and placed in tray.



Placing organic matter like pine straw, dried grass, leaves, etc. on loose soil can make a dramatic demonstration of the effects of rainfall on it versus uncovered soil.



Simulator table parts



Setting up the simulator - the frame

The table, whiteboards and spray pump and pipes are stored at the right rear of the trailer. The top whiteboard helps make the table more sturdy and the lower whiteboard conceals how much water is retained or running through the soil until it is revealed at the end.

Pump head and extension pipe.

NOTE: Be careful not to damage the power wire on the pump unit when fastening and unfastening from the trailer wall.

Folding table in front, whiteboards stored behind.



To set up table, remove pin and clip, rotate leg into position and re-insert pin and clip. Repeat for each corner.

Front whiteboard attaches with eyebolt pushed through hole in table frame and fastened with a nut.



Setting up the simulator - spray head

Connect the pump unit and the extension pipe together. Be careful not to strip the threads on the connector.

Position the unit at the desired height. You can adjust later if needed. Tighten knob to secure.

Attach water hose to water supply.

Route power cable away from water and areas where it might be damaged.



Setting up the simulator - water supply

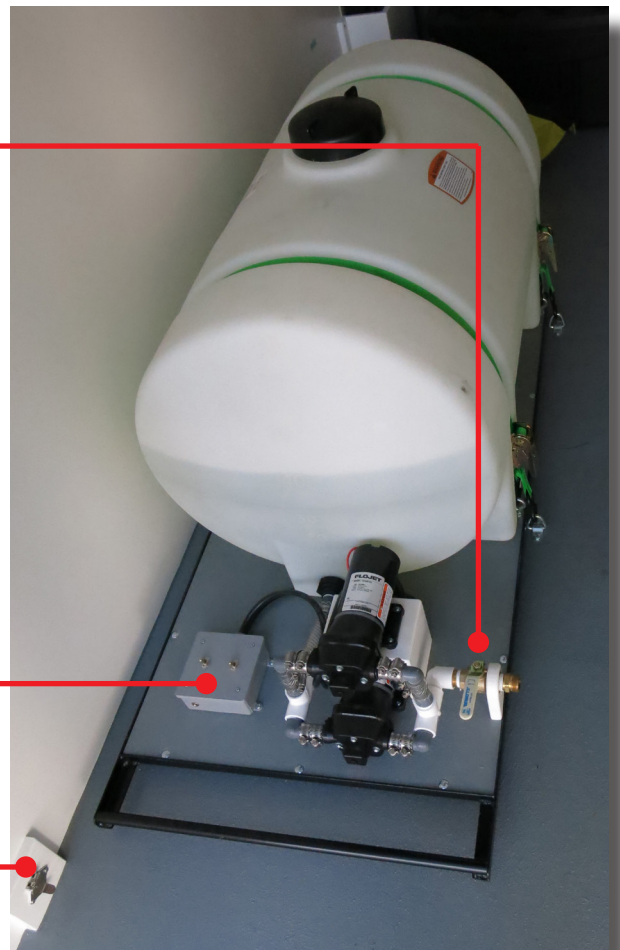


To be able to control water flow, attach one hose to the RFS pipe, the other to the water tank or local water supply and connect the two with the control valve.

If using the onboard water tank, connect the feed hose and use the lever valve to turn on the water supply from the tank.

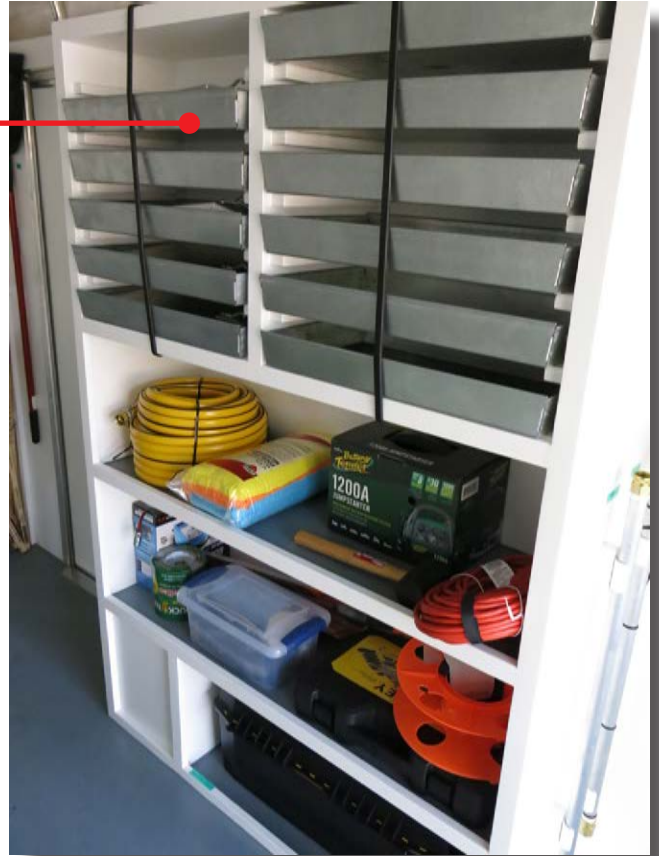
There are two pumps for the tank. One or both can be used. When you're ready, turn on. The pumps will start up as needed to provide water pressure.

DC 12V outlet for RFS sprayer if not using local AC power. There is also one on the same side of the trailer exterior front.



Setting up the simulator - trays

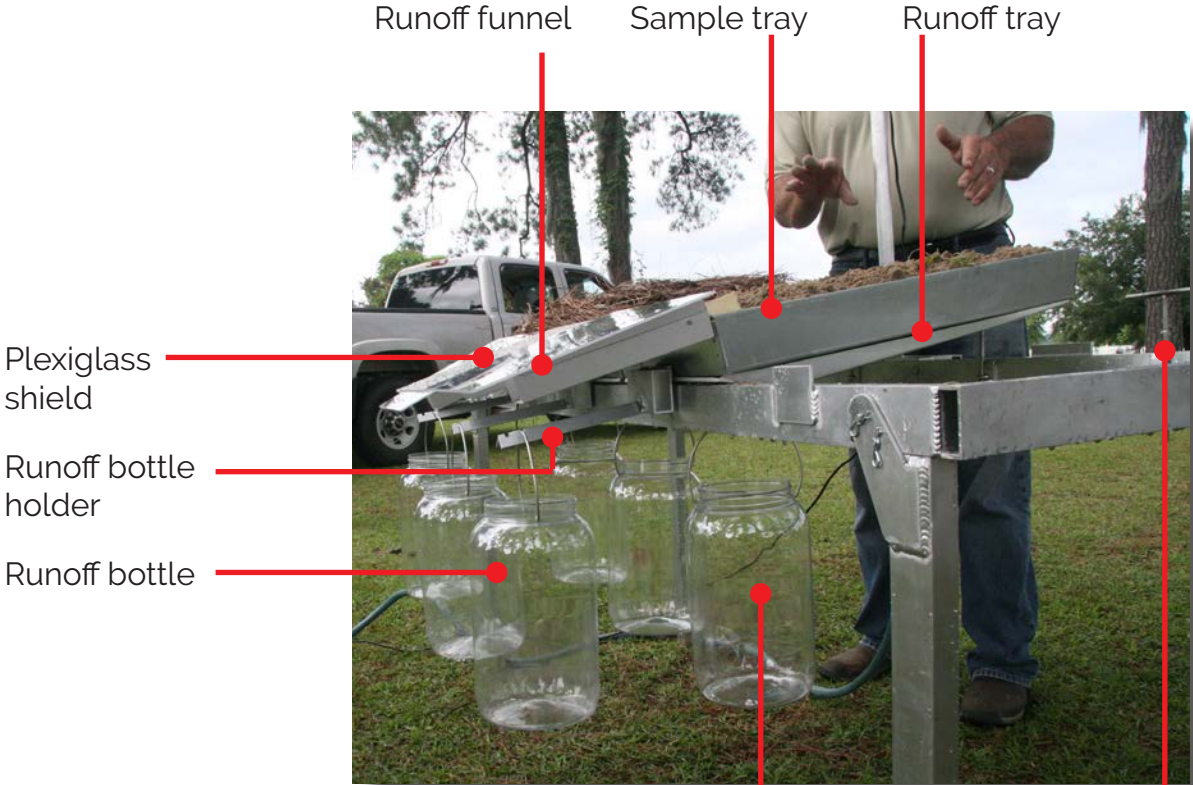
The sample trays, runoff trays, runoff funnels and plexiglass shields are stored in the cabinet on the right side of the trailer. The sample trays usually contain the other components, sometimes in felt bags.



Runoff trays being removed from storage from within sample trays. These will go on the frame, one beneath each sample tray.



Setting up the simulator - the assembly

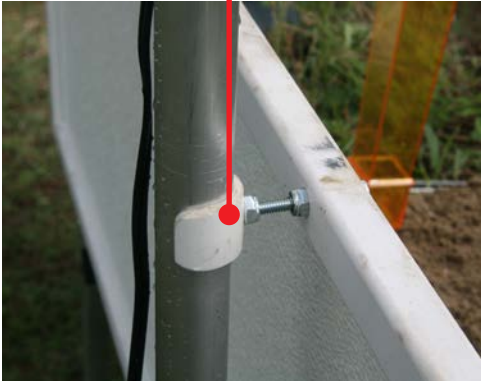


Pass-through bottle with S hooks T-bar risers

Funnels press into sample trays

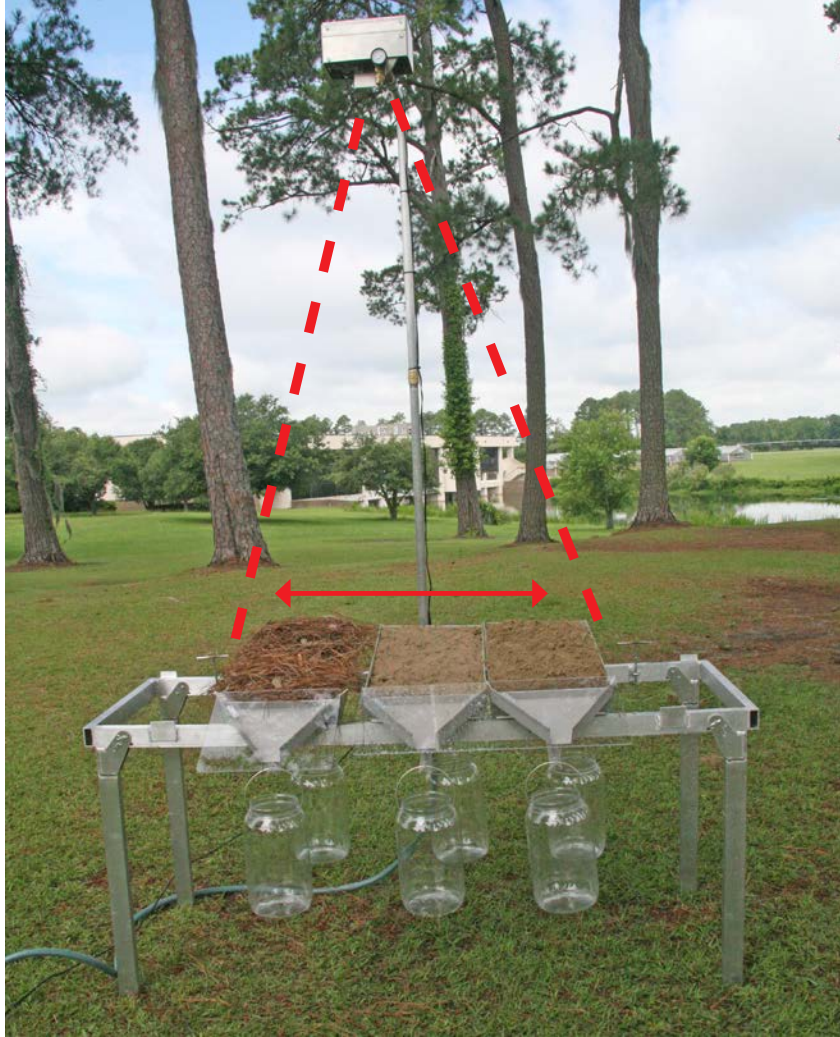


Top whiteboard has plastic clamp that fastens to water pipe.



Setting up the simulator - spray radius

Test your setup before the demonstration and make sure the spray pattern covers the sample trays edge-to-edge so the results will be accurate. Here, three samples are being shown. Up to five can be loaded on the frame.



Remember to place the rain gauges in two sample trays - equidistant apart.

Setting up the simulator - accessories



Each RFS trailer should have two water hoses, a shutoff valve, a spray nozzle for cleanup and rain gauges.



The power equipment is used to run the spray head on the demonstration table. The spray head pump runs on DC current. The power kit contains cables to supply the AC/DC converter with power from a local source.

If there is no AC current, DC current can be used by plugging the power unit into a DC outlet on the front of the trailer exterior or in an outlet between the water tank pumps and the rear door inside the trailer.

There should also be clamps that can be connected directly to a vehicle battery and a cigarette lighter plug that can be plugged into a vehicle outlet.

WARNING: USE EXTRA CAUTION WHEN CONNECTING TO AC POWER. KEEP THE CABLES DRY AND OFF THE METAL OF THE RFS TABLE.



The deep cycle battery that powers the pumps and spray head when not on AC power is behind a door in this cabinet.

Taking down the simulator

Please keep in mind that your audience will have more respect for your demonstration if your equipment and presentation areas are kept neat and clean.

Your fellow RFS users will respect you if you carefully clean the equipment when done and return it to its proper storage area.

Use the supplied spray nozzle to rinse soil off the equipment before storage.

Take special care with the plexiglass shields and bottles because they can easily scratch. Fiber cloths are provided with the equipment to wipe them.

Return all equipment to its correct storage area.

Don't leave anything on the shelf at the front of the trailer. It can fall off and become damaged during transit.

Make sure the sample trays and accessories, the table frame and whiteboards are secured by the rubber straps.

Empty the trash can and sweep the floor when done.

A checklist is provided on the next page to help you finish up.

Checklist for end of demo

- Wash soil off all equipment.
 - Dry collection bottles with fiber cloths being careful not to scratch.
 - Dry plexiglass shields with fiber cloths and store in felt bags, if available, inside sample pans.
 - Store collector bottle hangers, runoff pans inside sample pans or store them in the accessory shelves in an organized way so they won't shift during transit.
 - Snap the spray head pipe into position at the end of the cabinet. Be careful not to damage the power wire.
 - Snap the extension pipe into place beside spray head pipe.
 - Place the whiteboards, then the folded table frame into its storage area by the rear door and secure with rubber strap.
 - Place the template cutter in the wall box near the front left of the trailer.
 - Make sure the Sawzall is stored in its bag on the floor.
 - Hang the collection bottles from the ceiling at the front of the trailer.
 - In the winter, if the tank has water remaining, run the pumps to empty it to avoid freeze damage.
 - Neatly store the power source and cords in their plastic box and place on lower accessory shelf under pan storage.
 - Roll up any power cords used and store in same area.
 - Store any hand tools by trash can.
 - Replace sample buckets on shelf at front, secured by rubber strap.
 - Empty trash can.
 - Sweep floor. Store broom by front door.
 - Clean up or store anything else remaining.
 - Check trailer contents to make sure nothing can fall and be damaged.
 - Close and secure trailer doors, make sure you have the keys and lock the doors.
-

If there are any broken or missing parts or any other issues, e-mail info@scforage.org with the details.

Trailer storage reference

Bottle storage



Trays and accessories, other items



Cutter, Sawzall, trashcan, tools



Spray head and extension



Water hoses



Trailer storage reference

Template cutter, buckets, Sawzall



Table and whiteboards



Key points to make the presentation effective

Compiled by Kirsten Holland Robertson

Choosing samples:

- Bare Soil and Mulched samples should be taken from a regularly tilled field. They do not have to be taken in situ.
- Make sure your sample soil types are similar to where you are doing the presentation. This way the locals will be able to relate better.
- For grazers, make sure there is an overgrazed sample and a well-managed sample
- For growers, make sure there is a cover crop sample or at least a sample with cover crop residue.

General management tidbits to sprinkle through the talk-

- Nature doesn't fertilize or till, yet plants grow reliably. Think of forest and prairie. Both
 - Have every inch of soil covered with either mulch or living plants,
 - Are not disturbed,
 - Have lots of plants, with no bare soil
 - Have a diversity of plants. We want to mimic nature.
- Dirt + Life = Soil (Life = bacteria, fungi, nematodes, protozoa, microarthropods, arthropods, earthworms and plant roots)
- Unhealthy soils are sick, naked, starving, and beaten regularly - Ray Archuleta
- We don't have a runoff/erosion problem; we have an infiltration problem! -Ray Archuleta
- Start small when you're trying something new
- Rainfall is a free resource. There aren't many free inputs. Let's capture as much as we can.
- We can GROW soil!
- Plants do not have the ability to digest soil. They need microbes!

- **Grazing**
 - It's not the cow, it's the how. It's all about the management.

Before - Introduction

- Delivery
 - Be excited!
 - Talk loud and use a microphone and speaker **even if it is inconvenient.**

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Studies show that people will not admit if they can't hear you. They will simply tune you out. Also, a microphone gives you clout.

- Very important to have nice signage above each sample. If you can't print it on a computer ahead of time, make sure it is printed NICELY in CLEAN BIG DARK LEGIBLE letters! It does matter.
- Keep the simulator area tidy. Clutter distracts and detracts from the message.
- Things to tell them:
- Simulator is designed to drop the same amount of rain across all of the samples. It is to show what happens when rain hits the ground with different management practices.
- Make sure the rain gauges are in the management samples.
- Explain each of the samples - bare soil, covered soil, etc.
- Explain how the samples are taken.
 - Show a tray with holes in the bottom.
 - Note that they are 2" deep (important)
 - Explain that the samples with stuff growing in them are taken intact, straight out of the ground where they were growing.
 - The intact samples start out with some moisture while the tilled and mulched soils start out completely dry.
- Ask audience what they expect to happen.

During (while the rain is falling) -

- Take 1 extra empty jar and leave to the side within easy reach

It can be hard to fill in the time. Here are some things to say:

- This is a demonstration, not a realistic experiment.
- The jars in front show rainfall runoff from each sample. There are plastic shields over the 'funnels' to ensure that straight rain does not enter the front jars.
- May start to get splash-up on the back panel. Note and compare this for each practice.
- When water strikes the ground, it displaces the uncovered soil (see back-splash). It's important to note that it also reorients the soil particles so that when they settle back in, the lighter ones land on top/plug the macropores in the soil and form a seal or crust on top. This keeps rain from infiltrating. You are increasing runoff and decreasing infiltration.
- The single greatest threat to production in your fields is available soil moisture throughout the growing season.
 - Our growing season generally has long dry spells with quick bursts of

one or two inches of rain very quickly. Capturing that rain before it runs off is key to getting the most out of each storm.

- Capturing it has a great deal to do with what's on the surface -the canopy, the surface residue, and the soil structure at the interface of the soil and air.
- We're able to look at these different management practices, and we don't usually see this when we are out in the field. Who goes out and stands in a field when it's raining?
- This is probably a heavier rainfall than your land may ever see. Historical records never show rain this hard. Is this fair to use this as a demonstration? What is happening now with our rain events? Rainfall events are trending more frequently and more intense. Same with droughts.
- Talk in general terms: Pore space, water infiltration, and plant roots hold and filter water, leaves also reduce the force with which water droplets strike the soil surface, which reduces erosion. Students often infer that there is less run-off in the grassy sample because plant roots are absorbing the water into the plants' biomass; this process would not occur instantaneously, so make sure students understand the physical properties of the soil and the channels created by roots, earthworms, and other organic matter are much more important in this process. The grassy sample is like Swiss cheese with lots of holes and pores for water to flow through; the bare sample is more compact and impermeable.

After it rains

- NEVER say it didn't work, even if the jars didn't fill like you expected. It undermines the whole thing. Concentrate on the things that did work. Try to figure out why it didn't for some aspects and explain it, but never say it didn't work. Most parts of it will always work.
- Look at the rain gauges. Should be very similar amounts of rain in all. (important to note to audience)
- Front jars -
 - Compare colors first. Bare Soil will probably be darkest.
 - Now talk about each specific management:
 - Bare Soil
 - Pour Bare Soil water into the clean jar you had set to the side and leave the sediment behind in the original jar. Hold up the original jar with the sediment and note that we lost sediment off the land. Ask what else we lost (fertilizer, calcium, micronutrients, this is the

best part of the soil, also herbicides (which you want to see evenly applied across the field)). You've just either lost this soil and these inputs to your neighbor or redistributed on your land. Neither option is good.

- Ask how you would separate the soil back out of the water from the second jar. How would you take chocolate milk and make it white again? How do you get the chocolate out of the milk? You can't. The only way to clean that soil back up is to send it all the way back through the soil profile again. Healthy soil is the only thing that will clean up that sediment-filled water.
- Pour Bare Soil water back into its original jar with the sediment and hang it back on the peg (this will be better for pictures later).
- Mulched
 - Ask if the mulching helped. It always does.
 - Tell them that if you can't do anything else, even in your yard, at least keep your soil covered with a mulch.
 - There is usually some runoff, but very little sediment
- Cover Crops
 - How'd this one do? Should be pretty good.
 - Compare the Mulched to the Cover Crop. The Cover Crop is usually cleaner.
- Overgrazed
 - It's almost always as bad quantity and quality as the Bare Soil. Make note of this.
- Well Managed Pasture
 - Usually the cleanest with the least amount of water. Make note.
- Back jars -
 - Take white skirt panel off and lay on the ground below the Front jars. Take the Back jars off of their hooks and place on the white panel below the front, neatly and in a straight line. Make it so that if people take a picture to look at later, that it is easy to see what happened and as clear as possible to understand so that they can explain it to someone else if they want.
 - Bare Soil - very little water makes it through that 2" depth. This is why you told them in the beginning that the trays are only 2" deep. What color is the water in the Back jar?
 - Compare the Mulched quantity to the Cover Crop. The Cover Crop is hopefully better infiltrated.
 - Well Managed Pasture - note how much water infiltrates. We want to

keep the soil covered on top and like a sponge underneath.

- If you can, ALWAYS have a plastic sheet/tarp on the ground to turn the Bare Soil sample upside down on. The sample will probably be dry and powdery on the bottom-turned-upside-down.
 - Bend down and sift some of it through your fingers to prove it. There is always an audible gasp when you do this.
 - Ask how many inches it rained (this is why it's important for you to note it earlier). Even though it rained ___ inches (usually 2-4) during this simulation, it didn't make it even 2" into the soil!
 - It doesn't matter how much rain you get, it's how much rain your soil can hold.
 - We don't have a runoff/erosion problem; we have an infiltration problem.
- Ray Archuleta
 - Every inch of water you have going into your soil instead of running off is going to help grow more grass or crops.

Talk Generally about Soil Life

- All of life on earth is solar powered. Almost all of our fuel comes from the sun; fossil, wood fired, solar, even wind is started by warm air currents moving. So what powers the life in the soil? It's the sugars that come out of the plant roots that power the microbes. How do the roots get the sugars? The sun feeds the plant and it makes carbohydrates.
- A plant dumps between 40% and 80% of the energy it creates into the root zone. It seeps out of the roots. We think about roots uptaking water, but they also dump sugars into the soil.
- Why would they leak so much food into the root zone?? Isn't that a waste? Nature never wastes anything. Those sugars are to feed the microbes. The plant feeds the microbes, and what do the microbes do for the plants?
 - Bring the plant food that they take out of the sand/silt/clays
 - Create the aggregate structure for the plant roots to grow and thrive.
- Cover (like mulch) is good, but it's not enough. We need a living root to feed those microbes. It also helps with infiltration as we saw in the RFS (hopefully :-)

NOTES

APPENDIX

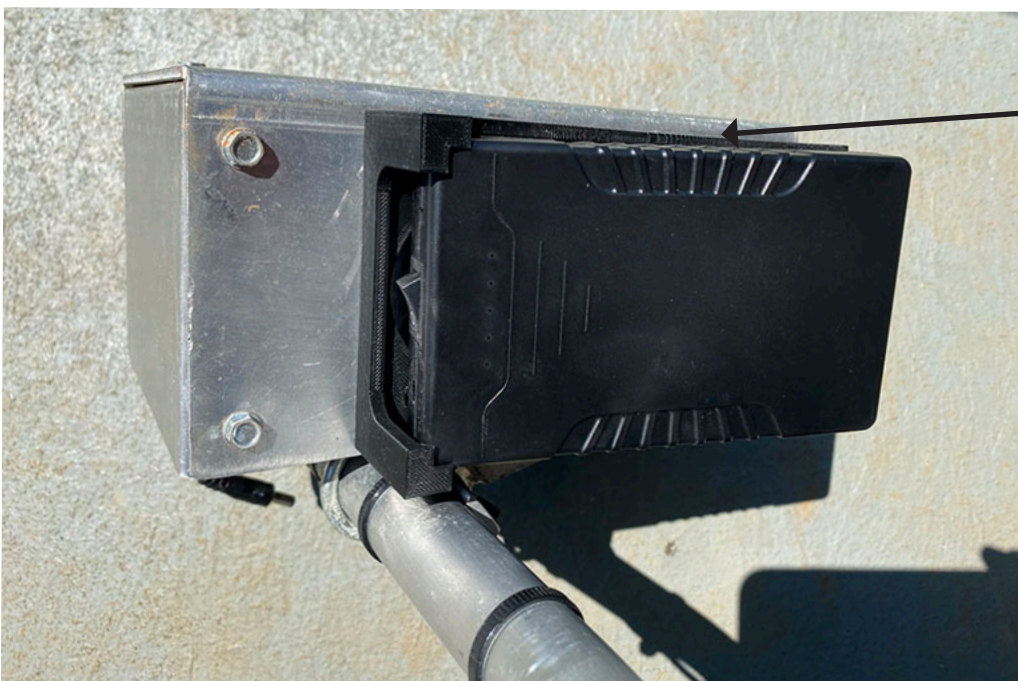
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Information for units with remote control head

Make sure batteries in remote receiver are charged before attending event.

New remote control head unit

Battery and receiver pack plug into cord connected to sprayer head.



Pack fits in holder. Power switch shown.

Remote control turns on power to both spray head and solenoid found lower on the pipe that turns water flow on and off.

