Expo / Desktop Rainfall Simulator
Instructor Guide

ANR Academy 2014/2015 Soil Health Project

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Directions for Using the Desktop Expo Rainfall Simulator

1. **Obtain a desktop or expo rainfall simulator from your state extension service, USDA-NRCS, local conservation district or by purchasing from Conservation Demonstrations, Salina Kansas. (6264C E Country Club Rd, Salina KS 67401, (785) 826-3215).**

Picture of Expo rainfall simulator in the case.

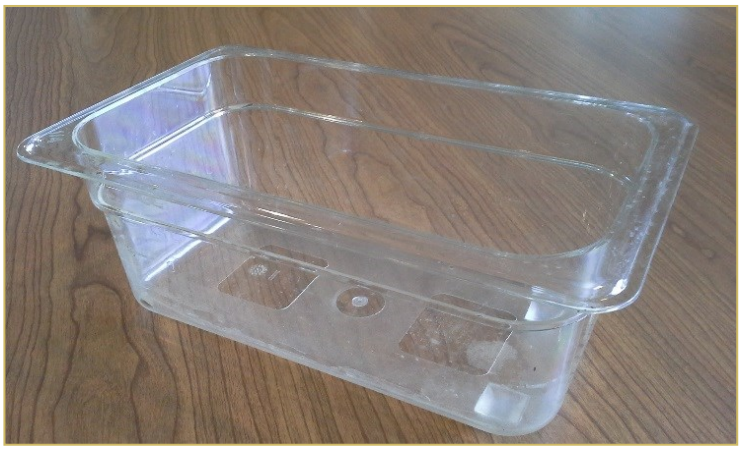
Note the arrangement of items to assist in placing them back into the case.

2. Look through the hardware and understand the components. The components include:

a. Soil cutter (stainless steel)

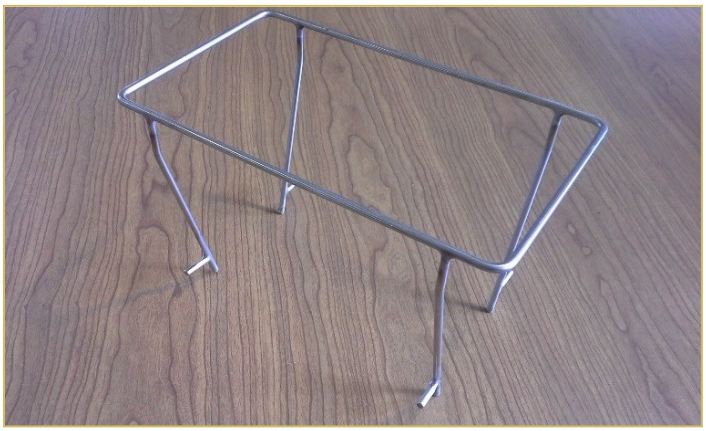
b. Screen (for the stainless steel cutter to rest upon)

c. Lower catch pan container (largest of all containers)



d. Upper drip pan with holes in bottom. Note the levelling tabs on the right hand side

e. Wire frame to hold upper drip pan



f. Run-off catch pan

g. Miscellaneous Tools

Shovel, wood block, small hand held sledge hammer (2-3 lbs), large stiff putty knife, storage containers for cutters, 2-16 oz measuring cups and water containers

3. Understand how to assemble the components

a. Place the screen on top of the lower catch pan container. Springs should face up and wire guide tabs should fit inside of lower catch pan container. Take note of elevation tabs on bottom side of lower catch pan container. These tabs are to simulate slope as in an actual field situation to create a run-off scenario.

b. Place the soil cutter on top of the screen with the water run-off trough at the opposite end of the elevation tabs on the lower catch pan container. Attach the springs to the holes in the top corners of the soil cutter.

c. Place the wire frame on top of the soil cutter with legs inside and supports resting on top edge.

d. Place upper drip pan on and in the top of the wire frame. Make sure the levelling tabs are located on the side of the rainfall apparatus with the water run-off trough on the soil cutter or opposite the side of the elevation tabs located on the lower catch pan container.

e. Place the run-off catch pan under the soil cutter run-off trough.

f. The final assembled expo rainfall simulator should appear as the following picture with the elevation tabs on the lower catch pan opposite to the levelling tabs on the upper drip pan and the water run-off trough on the soil cutter.

4. Obtain representative samples with the soil cutter

a. Determine what site conditions, land use or management practices you want to focus on. A good place to start is collecting cutter samples from no-till and conventionally tilled crop production fields. One could also include and make comparisons between established grass (turf), cover crops, disturbed urban sites, compacted areas exposed to wheel or animal traffic, etc.

No-till systems (right) leave more residue on the soil surface and preserve soil structure.

b. Locate a representative location within each field/area of interest for sampling. For example, if you want to compare no-till and conventional tillage try to obtain cutter samples from similar locations in each field considering soil type, crop/cover type, distance from the field edge, etc. The main factors that will influence water infiltration are soil texture, soil disturbance and soil cover (living plants or non-living plant residues). Answer the following questions about the sample(s) the help explain your rainfall simulator results.

   i. What is the texture of your soil sample? Obtain from Web Soil Survey (websoilsurvey.nrcs.usda.gov) or by conducting a Feel Test for Soil Texture (see student worksheet). Soil texture will be one of the following: clay, sandy clay, silty clay, clay loam, sandy clay loam, silty clay loam, loam, sandy loam, silt loam, silt, loamy sand, sand

   ii. Describe the level of soil disturbance and length of time since the last tillage pass or disturbance by urban development. This information may be obtained from a farmer or land manager. Disturbance can be categorized as:

   - No-disturbance/tillage (established turf, forage, direct seeding crop production)
   - Medium disturbance/tillage (annual urban plantings, vertical tillage, mulch-till)
   - Heavy disturbance/tillage (active urban development, moldboard plow, rotary tillage)

iii. Describe soil cover at your sampling site(s). Soil cover can be categorized as:

- Bare (no living plants or plant residues on soil surface)
- Minimal cover (<25% of soil surface covered)
- Somewhat covered (25-75 % of soil surface covered)
- Mostly covered (>75% of soil surface covered)
- Living Plants (record types of plants, i.e. grasses, broadleaves or a mix)

This no-till field site has 100% of the soil surface covered with crop residue

c. After a representative sampling location has been located, take note of how much residue is present on the soil surface, then remove residue from the sampling area. Residue removal is required because the cutter edges can hairpin large residue pieces and alter your demonstration results. Trim any living plants in the sampling area to one inch above the soil surface.

Soil cutter placed on soil surface after residue removal

d. Place the cutter on top of the soil surface. Either push the cutter into the soil by hand or tap/ pound it in with a wood block and small sledge hammer. Care needs to be taken not to disturb the soil surface as soil pores could be plugged, preventing water infiltration. Push or pound the cutter to the depth at which the run-off trough is level with the soil surface.

Wood block and small sledge for driving the cutter into harder soils

e. Next, excavate the soil cutter without disturbing soil inside the cutter. Use a shovel to carefully dig along the outer sides of the cutter. Excavating along one long and each short side of the cutter is generally adequate.

Excavated soil cutter

f. Gently break the cutter loose from the soil by pushing and lifting it towards the excavated side of the cutter. Again, it is important to recognize that one should be careful to not disturb soil inside the cutter.

Be careful to not disturb soil inside the cutter when lifting it from the soil.

g. Once the soil cutter is loose from the soil, clean the sides of the cutter with the stiff putty knife. Care should be taken to not set the cutter down on rough surfaces that could disturb soil on the bottom side of the cutter. If soil extends below the cutting edge of the cutter, gently break the extension off. Do not cut or slice extra soil from below the cutter because soil pores could be plugged and skew your results. The objective of this process is to prepare the cutter to sit on its cutting edges in a storage container. **Also at this time, collect an additional 10 cups of intact soil from your sampling area(s) for students to use in the Feel Test for Soil Texture.**

h. Place the cutter containing your sample into a storage container. Replace any residue removed prior to sampling. Short term storage of the filled cutters is very easy, but long-term storage can be difficult. Avoid letting soil dry while inside the cutters by selecting storage containers with lids to seal in moisture. Soil drying will cause shrinkage and allow voids to form along the soil/cutter interface causing preferential flow and skewed demonstration results. If shrinkage does occur, one can gently fill these voids with crumbled soil.

Plastic bins with a cover work well for storing and transporting samples.

5. Demonstrate the desktop expo rainfall simulator

a. Set-up the desktop expo rainfall simulator with soil in the cutters (see pgs. 2-6)

b. Put 16 oz. of water in each measuring cup.

The fully assembled rainfall simulator with samples in the cutters

c. At this point in the demonstration, describe any known differences between the samples that you have in the cutters and point out the effects of soil texture, structure, disturbance and cover on the movement of water over and through soil. Note how uncovered and disturbed soils have poor aggregate stability and will quickly lose integrity when exposed to rain drop impact, resulting in soil and water running off into the catch pan.

d. Pour the water into the upper drip pan(s). The water will immediately start dripping onto the soil in the cutters.

e. Water will soon start running-off the soil into the drip pan and/or infiltrating into the soil and entering the lower catch pan. Eventually, the water will run out from the upper drip pan and stop dripping onto your sample(s).

f. Now the demonstration is basically complete and one can evaluate if another 16 oz of water should be added to the upper drip pan. First, make sure the run-off drip pan and lower catch pan have available space for more water. The reason to add more water to the upper drip pan is continue the demonstration and further highlight the differences between two soil samples in the cutters.

6. Interpret your results

a. If your samples accurately represent field conditions and were not compromised during collection, transport and storage, there should be more water in the run-off drip pan from the soil sample with a finer texture, greater disturbance and/or less cover.

b. Discuss with students how texture, disturbance and cover can influence the amounts of water in each of the catch pans. Tillage and other disturbance prevents the soil from forming stable aggregates and pores that permit the movement of water through soil. Soil cover absorbs the impact of raindrops to protect soil aggregates and encourage infiltration. The following picture shows a comparison of conventional tillage (left) and no-till (right). Notice the difference in amount of water in the catch pans. The conventional tillage sample has more water in the run-off pan while the no-till sample has more in the lower catch pan indicating greater water infiltration and drainage.

c. Point out that the color of water in the various catch pans is an indication of how much soil has eroded from the sample. Explain that the dirtier water likely contains nutrients (N and P) that contribute to water quality problems in local streams, rivers and lakes, as well the hypoxia problem in the Gulf of Mexico.

d. Ask students to discuss the implications of water in each pan. More water in the lower catch pan(s) indicates more water available for crops in drier climates and greater ground water recharge. More water in the run-off drip pan indicates more erosion and loss of soil and nutrients, which is not sustainable.

Good Luck! From the 2015 ANR Academy Soil Health Team