What Combination of Conservation Practices Protect Soil the Best?

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St. Mary of the Immaculate Conception

Contents

Abstract

What combination of conservation practices best protects our soil? I created four "test plots" in aluminum trays to figure it out. My first "test plot" was plain soil - a conventionally tilled field of bare dirt. My second "test plot" was plain soil with straw on top - a no-till field with no cover crops. In my third "test plot" I planted cereal rye and oats to recreate a conventional field with a cover crop. My last "test plot" had cereal rye, oats, and straw, representing a no-till field with a cover crop. To test my plots I set up a rain simulator on my patio. I had a gallon of water in a watering can and held it 12 inches above the tray, then steadily poured the water back and forth so it drained into a large tray. After all the water was poured, I took the runoff and poured it into graduated cylinders to measure the amount of water and sediment that had come through. I hypothesized that the fourth tray - the no-till field with a cover crop - would be the one that had the least amount of runoff. My hypothesis was correct, but even though I thought that the combination of no-till and cover crops would be the best for erosion prevention I was still surprised by how clear the water was. I think this experiment would be excellent proof to show to farmers who might not be using conservation methods yet.

Question

What combination of conservation practices protects soil the best?

Variables

The ***Independent Variables*** that I tested for were whether the "test plots" were conventional or no-till and whether they had cover crops or not.

The ***Dependent Variable*** that I discovered was how much water and sediment came off of each tray.

The ***Control Variables*** that I focused on were:

1. The same tray is used for each "test plot".
2. The same type of soil used in each tray.
3. The same amount of soil in each tray.
4. The same amount of cover crops planted in trays 3 and 4.
5. The same amount of straw from the same bale used in trays 2 and 4.
6. The same degree of decline for each tray.
7. The same amount of water poured over each tray.
8. The same velocity of water poured over each tray.

Hypothesis

I hypothesized that the fourth tray, the one with the most amount of cover crop and straw, would do better to prevent erosion than the rest of the trays. The fourth tray had the most roots and straw that would slow the water down and keep it from washing away.

Background Research

According to the Soil Science Society of America (SSSA) "In short, soil is a mixture of minerals, dead and living organisms (organic materials), air, and water. These four ingredients react with one another in amazing ways, making soil one of our planet's most dynamic and important natural resources." Without soil we couldn't live. I want to look at farming specifically and without soil we couldn't grow our food because we wouldn't have anything to plant into, anything to hold water for the roots, or any nutrients to feed the seeds. Even though soil is a renewable resource it can take hundreds of years to make just an inch of new soil.

Erosion is the process of soil getting worn away by natural forces like wind or water. People plowing up land to use for agriculture can speed up the process of erosion. Irresponsible farming can cause huge disasters like The Dust Bowl. In that event, millions of tons of topsoil were blown away from 150,000 square miles because the dry ground was plowed too much. Drought and high winds caused "black blizzards" that blew away valuable soil and ruined the land for years. However, the major cause of erosion on Earth is water. Usually, it's rain that causes erosion, but it can also be from things like snow melting or irrigation.

There are four kinds of water erosion. The first kind is sheet erosion. That's when a thin layer of soil is washed away from a large area. The second kind is rill erosion. That's when running water carves little streams or “rills” into the ground. The third kind of erosion is gully erosion. This is when water creates gullies or deep channels in the ground. These are big enough that you can’t fix them with farm equipment. The fourth kind is splash erosion. This is when the soil gets moved away as far as three feet by the splash of raindrops. The good news is that there are ways to help the soil stay where it is, so events like dust bowls or big washouts don’t happen.

One way to help prevent erosion is to use no-till farming. The United States Department of Agriculture (USDA) says that tillage is “turning the soil to control for weeds and pests and to prepare for seeding.” The bad thing is that, like they did with the Dust Bowl, if you do it too much it can make erosion worse and so you lose soil and nutrients. So to keep that from happening some farmers use no-till farming. This is when you slice into the ground to make a place to plant a seed instead of digging the dirt all up. There are a lot of benefits to no-till farming. Reducing erosion is one of them but it’s also good for putting more organic matter into the soil and increasing biological activity. This can save farmers money over time because they won’t need to buy as much fertilizer. Farmers can also save money by using less fuel because they aren’t using their equipment to go over the field a bunch of times to work up the ground.

Another way farmers can decrease erosion is by planting cover crops. The Sustainable Agriculture Research and Education (SARE) website says that a cover crop is “a plant that is used primarily to slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and disease, increase biodiversity and bring a host of other benefits to your farm.” According to the USDA farmers planted 15.4 million acres of cover crops in 2017 which is a 50% increase from numbers in 2012. And estimates from 2021 show that even more farmers are planting cover crops. Maybe as much as 22 million acres. It is estimated that about 57% of farmers plant cover crops. Farmers have a lot of cover crops they can choose from and it really depends on what benefit the farmer needs the most. There are great tools out there like the Cover Crop Decision Tool on the web site of the Midwest Cover Crops Council. All a farmer has to do is put their information into the online tool and it will tell them the best cover crops to plant! For my experiment I used a mix of cereal rye and oats because they are top rated cover crops for helping prevent overall erosion. They keep a strong grip on the soil with deep roots.

Unfortunately not everyone uses cover crops. One big reason is because it costs money to get the seed. Sometimes the weather doesn't cooperate. Like on our farm last year we didn't get our cover crop planted because it was too wet and then it was too late. This year we weren't able to do it because our harvest was too late and we missed the window to plant our cover crop. So it doesn't always work out, but if farmers did it as much as they could it would really make a difference by helping prevent soil erosion.

Images

Weighing soil for my “test plots”

Weighing cereal rye and oats for cover crops

(L to R) tray 1 (conventional), tray 2 (no-till), tray 3 (conventional w/ cover crop), tray 4 (no-till w/ cover crop)

Setting up my experiment - measuring my angle for runoff

Run off from tray 1 (conventional, no cover crop)

Measuring runoff from tray 1

Run off from tray 2 (no-till, no cover crop)

Measuring runoff from tray 2

Run off from tray 3 (conventional with cover crop)

Measuring runoff from tray 3

Tray 4 (no-till with cover crops)

Measuring runoff from tray 4

Materials

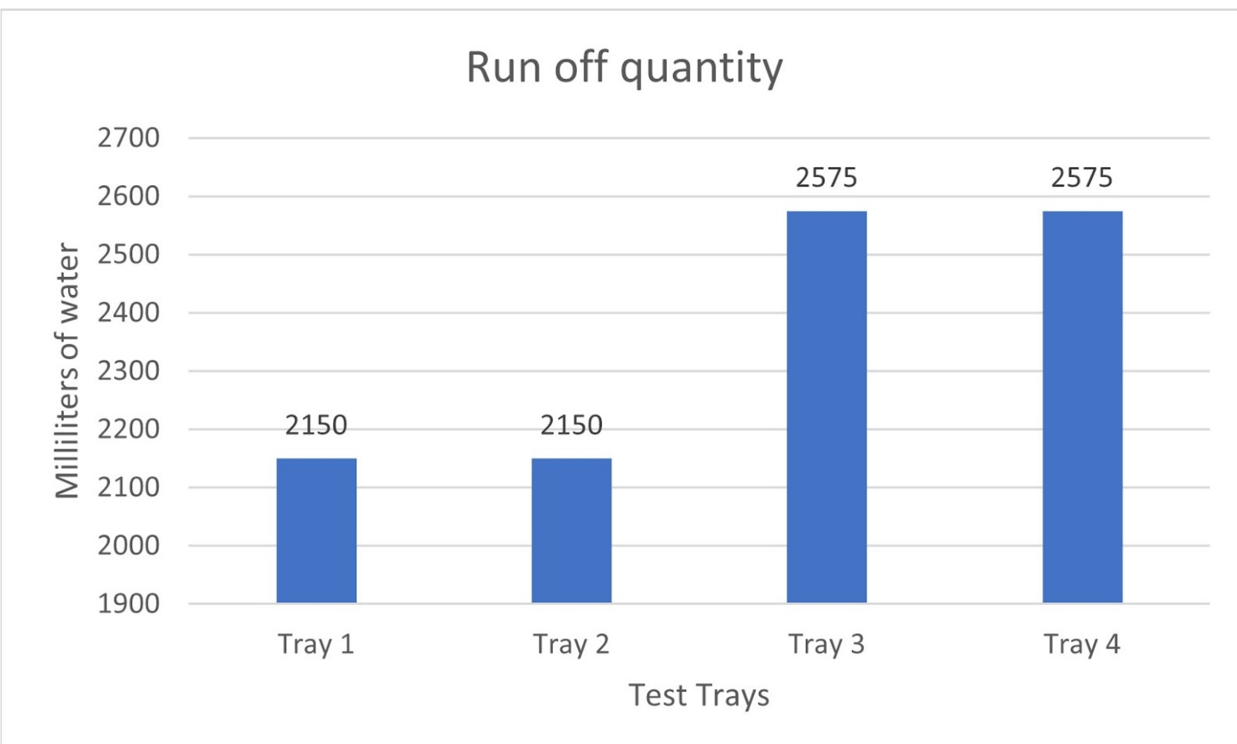
- 4 aluminum trays (9” x 11.5” x 2.5”)
- 1 bag Scotts premium topsoil (.75 cubic feet)
- 1 kitchen scale
- Cereal rye seed
- Oat seed
- Wheat straw
- Stone patio seating wall
- Patio end table
- 2x4 board
- Milk jug (1 gallon)
- Garden hose
- 2 watering cans
- Cordless drill
- ⅛” drill bit
- Three graduated cylinders (1 liter)
- 2 large aluminum tray (16.5” x 11.5 x 4”)
- Pen
- Notebook
- iPhone camera to document project

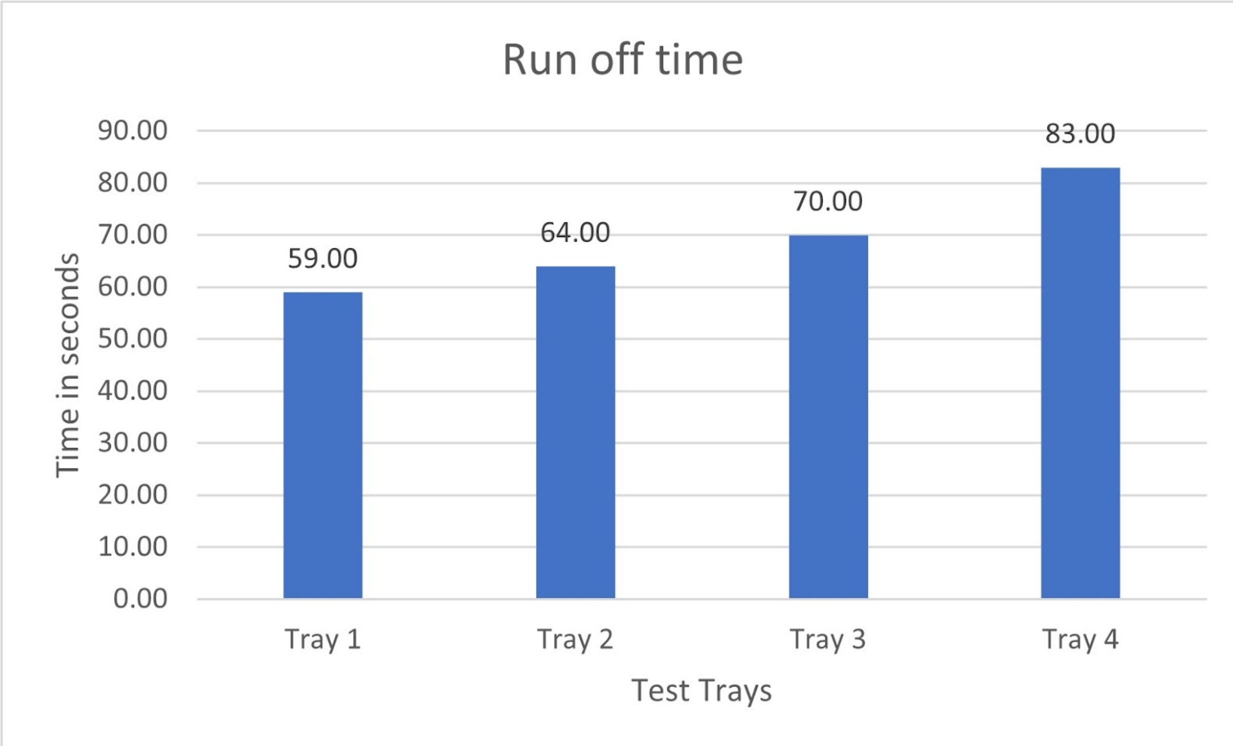
Experimental Procedure

1. Purchase materials to create “test plots”
2. Weigh out 4 pounds of topsoil into each aluminum tray
3. Plant 20g of cereal rye and 20g of oats into trays 3 and 4 (40g of seed in each tray) to simulate cover crop planting
4. Cover trays 2 and 4 with 1” of wheat straw to simulate no-till crop residue
5. Water and monitor cover crop trays. Move them in and out of the garage for sunlight and rain.
6. Put the first plot tray on the stone seating wall; use a 2x4 to prop up one end of the tray
7. Use the patio end table to hold a large aluminum tray under the edge of the plot tray to catch the run-off.
8. Line up graduated cylinders in a large aluminum tray on the seating wall
9. Use a gallon milk jug to measure a gallon of water and fill the watering can
10. Hold the watering can about a foot over the plot tray and evenly sprinkle the water
11. Once the runoff stops, pour the runoff into the graduated cylinders to measure
12. Document the measurements and observations in a notebook
13. Document the run-off with pictures
14. Repeat for the other three plot trays

Data Tables

Test Tray	Amount of RunOff (ml)	Run Off Time (sec.)	Run Off Color
1 (conventional without cover crops)	2150	59	black
2 (no-till without cover crops)	2150	64	dark brown
3 (conventional with cover crops)	2575	70	yellow
4 (no-till with cover crops)	2575	83	clear





Data, Analysis & Discussion

I had two setbacks while working on my project. The first one was that a raccoon accidentally got shut in our garage one night and it tore through my first conventional cover crop tray (tray 3). It totally destroyed it; dirt and rye plants were all over the floor. So I had to redo that tray - measure out new dirt and seed and start over. Thankfully rye grows quickly so it only took a couple of weeks to get back to the point where it was before the attack. The second setback was while I was running the actual experiment, I didn't think the water came out of our first watering can fast enough or evenly enough to really simulate rain so I drilled some extra holes in the spout. Unfortunately, it ended up making the water come out way too fast and it splattered my first tray (the conventional tray, just bare dirt) all over the patio. So my dad and I went to Tractor Supply and got another watering can that had a bigger head on the spout with a lot more tiny holes and it ended up being perfect for the job. I recreated another tray 1 and ran the experiment again.

Even though my hypothesis was correct, there were still some things in my data that surprised me. When it came to the color of the runoff, even though I knew the first tray of bare dirt would probably produce the most runoff I was really surprised by just how much sediment was in the water. On the other side, it was neat to see just how clear the water was from tray 4 - the no-till with cover crops. It looked like the water had gone through a filter, which I guess it kind of had. When it came to the amount of water that ran off of each tray, I was surprised by how much more water ran off of the trays with the cover crops. In the trays without the cover crops, so much of the water filled up the trays and saturated the dirt, but in the trays with the cover crops it was like the plants blocked the water and more of it ran off the tray without getting down into the dirt. I had also never really thought about the amount of time it would take for water to run through a field. It was neat to see how quickly the water went through tray one, but it took a lot longer to go through tray 4. It makes sense that the plants would slow down the progress of the water, but it was neat to see it happen in real-time. So even though my hypothesis was correct, it was really cool to see how it works in person and not just in theory.

It would be interesting to expand this experiment in the future by testing different cover crops to see if one is significantly better than another. I just tried cereal rye and oats this time, but there are lots of different options. Also, the way the seed is planted can make a difference. In this experiment, I simulated a broadcast type of planting, but there are other methods that can be used too. Broadcast planting is when you just scatter seed over a big area. A farmer could also use a piece of equipment called a drill or a planter that cuts the soil and then puts the seed into the ground and covers it up with soil. A planter usually gets better results, but it also costs more money to use and it's slower. I could also test more about how the amount of elevation change makes a difference in erosion. It might also be neat to test the soil to find out what cover crops do for the nutrients in the soil. One of the cover crops I tested (rye) is recommended by the Midwest Cover Crop Council and Ohio State University as being great for fields that are going to be planted as no-till soybeans. It would be interesting to show the nutrients left from cover crops to see how they might help increase yields and help save money on fertilizers.

Conclusion

In conclusion, everything worked as I had hypothesized. Even though I didn't make a big earth-shattering discovery in my experiment, it was very fun to learn how to protect soil from erosion. Cover crops are a very simple way to solve a very big problem and in combination with no-till farming, they can make a huge difference in preventing erosion. I hope my results will persuade someone to try new practices on their farm!

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