Background for using the infiltration/runoff model.

Soybeans planted using no-till

The samples of soil in these models came from Hendricks County, Indiana. The samples were extracted from the field in 2004 and wrapped and stored in cellophane to minimize disturbance. When these samples were unwrapped for use in this display, soil critters were doing well. They had consumed all of the natural residue from the samples and turned the surface of the no-till soil into a loose fine granular structure.

Corn planted using conventional-tillage

The natural residue was replaced with residue from fields in Ohio to simulate the natural condition of fields planted using conservation methods.

The models were assembled and the following results observed. Within a few seconds the water falling on the conventional tilled sample had sealed the surface and started running off, resulting in a muddy surface and dirty runoff water. Of the two no-till samples, it

Conventionally tilled sample

No-till with macropores filled

appeared that the macropores in one of them had been filled with the fine granular soil created by the soil critters. The water that was applied to this sample did infiltrate into the granular surface, but not fast enough to accommodate all of the water applied. The result was clear runoff water and a significant amount of infiltrated water which ended up in the pan below. As for the third model, it appeared that the macropores were stable and did not fill with granular material. The result was 100 percent infiltration and no runoff from this sample.

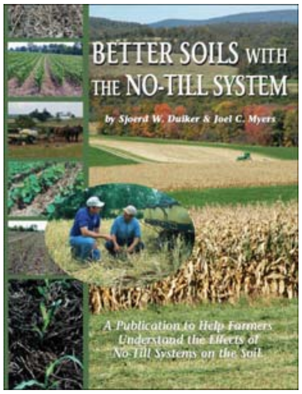
No-till with undisturbed macropores

These results are consistent with observations in the field. Generally, the runoff from no-till fields is significantly less than that from conventionally cultivated fields, and if there is runoff from no-till fields, it contains less sediment.

If the samples ever get too wet or if the samples are vibrated or bumped, there is a good chance that the macropores will close.

All three infiltration/runoff models

Generally, there will be critics of any demonstration. How do you answer the critics?

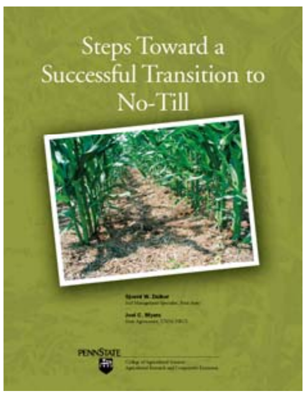


Environmentalists and farmers using “traditional” methods of cultivation generally will voice concerns over “no-till” practices. Pamphlets such as:

Better Soils With the No-Till System

http://panutrientmgmt.cas.psu.edu/pdf/rp_better_soils_with_noTill.pdf

and



Steps Toward a Successful Transition to No-Till

http://www.ngdc.wvu.edu/~hferguson/educationNGDC/OM_videos/uc192.pdf

are much better at providing the background to answer these questions than I, but I will answer a couple of them here.

1. No-till can not replace filter strips. Just look at all the mess in the ditches and woods after a torrential downpour. How can you suggest that no-till can replace filter strips?

No-till or conservation planting is a system. If filter strips are a necessary part of that system, then so be it. However, you should ask yourself: If no-till was not used, what would have happened? Chances are much more soil would have run off all the way to the receiving water. The results would not be visible because the sediment went all the way to the stream instead of being trapped in ditches and woods like the residue was. The use of conservation planting and filter strips can be complementary practices.

2. What about all those herbicides that have to be used? Aren't they more harmful to the environment than tillage?

Actually, farmers using conventional tillage methods must use herbicides as well. You just do not see the dying plants, so you do not recognize that they are being used. By not tilling, the farmer using conservation planting is planting the crop and not planting the weeds from the season before. If the weed seeds are left on the surface, they can be eaten by rodents and other grazers. They also are more easily killed by contact herbicides. Over time, there will be fewer weeds in a well managed conservation planting system, so less herbicide will be required.

3. What about the harmful effects of the insecticides?

Once again we have to look at the conventionally tilled situation. If crops are rotated, then the potential for pests thriving through the rotation is minimized. Whether it is conventional tillage or conservation planting, the same principle applies. The more diverse the crop rotation, the less insecticide is required.

4. What about all that water that infiltrates? Will it carry more pollutants to streams?

It depends upon how well the management system is working. If the conservation farmer can cut down on herbicides, insecticides, and fertilizers, then there is less chemical to be leached. In addition, the higher content of organic matter in the soil means that there is a greater likelihood that the herbicides, insecticides, and fertilizers will become bound in the soil rather than leaching into the drainage water.

5. If long term no-till (conservation planting) is so great, how come more people are not doing it?

Conservation planting is a whole series of systems that take some skill to learn. What works on one kind of soil may not work so well on another. What works for one type of rotation may not work for another. Since farmers depend upon their crops for their livelihood, they are conservative in trying new management practices. They can not afford to fail. As a result, incentives have been issued to encourage farmers to try these new practices. Just the depth setting on the planter can mean the difference between 100 percent success and utter failure. As farmers learn the systems, conservation planting will continue to grow, but it is taking a long time. In some cases, fields will not be converted to conservation tillage until the current managers retire or sell out.

More general background concerning the infiltration/runoff model.

What is unique about the soil infiltration/runoff model? This model consists of 3 1/2 inch by 8 inch stainless steel cutters designed to take undisturbed samples of the surface soil from the field and bring it into the classroom.

Who made them? The prototype was made in Fletcher, Vermont, by Cleon Gilleon. This particular set was designed by Drake Asberry, a student at West Virginia University, and constructed by the support staff for the research at West Virginia University.

Where were they used? These mini-soil-lysimeters were used on a field tour at Beck’s 2004 Pre-Harvest Field Show to demonstrate infiltration in long-term (14th year) no-till plots as compared to conventionally tilled plots. Since then, they have been used at soil quality classes in Price, Utah, and Wasilla, Alaska.

They have also been used in demonstrations at the State Fair in Indiana; an Extension Specialists' meeting in Washington, DC.; a field tour for the World Congress of Soils in Leesport, Pennsylvania; and the soil quality cadre meeting in Greensboro, North Carolina. They have been used to create movie clips and posters that are distributed via the Web. Several more sets of mini-soil-lysimeters were made for educators in Indiana and have been used on field tours and demonstrations in several Indiana counties.

How were they used? The cutters were used in two distinctly different ways.

1. One was to simply extract samples from the plots which could be shown to the spectators by bringing the soil to them (cutters half full of soil). This allowed the spectators to see the differences in soil quality up close and personal. The conventional soils were much drier and were noticeably crusted. They also lacked macropores. The no-till soils were dark and moist. The no-till soils had many macropores (mostly worm holes) that were visible both from the top and the bottom of the cut sample.

2. The second was to extract a sample that filled the cutter completely. This sample was placed on a screen and rack system. Water was sprinkled on the top of the samples and allowed to either run off or infiltrate. An excess of 6 quarts of water infiltrated through the no-till, and less than 2 or 3 ounces ran off during two days of demonstrations. An excess of 6 quarts of water ran off the conventional sample and only a couple of ounces infiltrated during the same time period. The vast difference was a result of the crust that had developed on top of the conventionally tilled field. The no-till field was actually being "tilled" all season by the natural inhabitants.

3. Those individuals who observed the samples being dumped out at the end of the demonstration were the most impressed. The bulk of the conventionally tilled sample was still hard and dry, but the no-till sample was nearly completely saturated with water. It was possible to see how the water followed the large holes down through the soil and wet the matrix of the soil from within. In addition, the increased aggregate stability resulted in many finer pores, and the soil wetting front extended from the top of the soil and much farther than the centimeter or so for the conventionally tilled sample.

Tips for the educator (Midwest):

1. These cutters allow you to bring a natural undisturbed sample of soil into the classroom. For the experiments to demonstrate what happens in the real world, it is very important that the soil sample be undisturbed.

During the spring and early summer, the soil is soft and the cutter will slide in with little effort. A flat board placed over the cutter can help provide even pressure as it is pushed or driven into the ground. This can be done by standing on the cutter, or for lightweights, a rubber mallet works great.

Later in the summer the conventionally tilled soils will become hard as a brick. If you take along a bucket of water, you can saturate the soil first. Insert the cutter part way, pour water down the side of the cutter so that you do not disturb the surface of the soil, and fill the cutter to the top. Find something else to do for a couple of hours. When you get back, press the cutter into the soil with even pressure. Not only does the water have to moisten the soil, but the soil has to come to some moisture content below saturation or you end up with a muddy mess while trying to extract the sample.

To get the cutter out of the soil, you can dig around it, or you can use a clawed hammer to pull the cutter out of the ground. The soil generally parts reasonably evenly across the bottom.

These cutters work best in silt loam soils with little or no gravel or rocks. However, I have used them in heavy clays and even loamy sands. Some soils will have a high infiltration rate due to the coarse texture or high aggregate stability of the clays. The cutters can be used to demonstrate other properties of the soils in these cases. By placing equal quantities of water on each sample, it may be possible to demonstrate the greater water-holding capacity of no-tilled soils. It all depends upon the organic matter content and the nature of your undisturbed samples.

2. The soil sample will become weak as it becomes saturated. It is important that the cutter be filled with soil to the top, or it will settle and slide down into the cutter as it becomes saturated. The idea is that the top of the soil should not settle below the exit spout.

3. Slope is not really that important. The more level you can keep the sample, the more realistic and impressive your results will be. Try to imitate the natural slope of the field that the sample was extracted from.

4. The coarseness of the wire mesh is not that critical, but a screen similar to a window screen must be used on top of the mesh or rack to keep the soil from falling out of the cutter and into the pan.

5. Practice.

Experiments on natural systems always "work." However, the results may not be as expected. The more an experiment is performed, the greater the understanding of the natural system that will be gained. A soil scientist from the cooperative soil survey can be called upon to help educators understand the soil system.

If a particular outcome is desired, run the experiment on similar samples prior to the demonstration to verify that the natural system will provide the desired outcome.

Examples: Sandy soils will have great infiltration whether they are tilled or not. There is probably not much chance of showing agronomic runoff with sandy samples.

However, foresters can use these same lysimeters to show runoff from hydrophobic sandy soils. (If there are not too many rocks and if a sample can be obtained in spite of the roots.) (Practice does not help here. The soils have to be dry to be hydrophobic. Once wetted, the hydrophobic nature goes away.)

Water will infiltrate for a while into silt loam soils that are conventionally tilled before a crust is formed and runoff takes place. Typically, this does not take very long and is often a matter of seconds.

If there are cracks between the mini-lysimeter and the soil, the water will go down the crack instead of going out the spout at the end. To avoid this, avoid "rocking" the cutter back and forth as you press it into the ground. I have found that you can place a board on top of the cutter and drive it in the ground with a rubber mallet and still get a relatively undisturbed sample. In the worst case, manually push the soil against the crack to seal the edge. There will be plenty of soil surface in the center of the lysimeter to show the natural condition.

Understand the history of the sample. A sample from a field that has been in no-till for only 1 year may act more like a sample from a conventionally tilled field than a no-till field. If anhydrous ammonia is injected into a no-till field, a sample taken near that disturbance may act more like a conventionally tilled field. It depends upon how well the worms survived the gassing.

A sample from a field that was conventionally tilled for years but had manure applied to it may be very different from a sample from a field with no addition of manure.

6. Don't bump the table.

If your experiment/demonstration goes on for hours or days as ours did, the no-till soil will become saturated. Saturation makes soils weak and susceptible to compaction. Jiggling the table can cause pores to collapse and cut down on infiltration.

Is this the opening for more experimentation?

If you set up multiple lysimeters (infiltration/runoff models), you can show how delicate soils are and why the worms are necessary to continually open pores to the surface for the system to work.

You can also demonstrate the importance of waiting a couple of extra days before planting to ensure that the soil is strong enough to retain its structure.

7. Practice varying the rates of "rainfall" that you apply to the lysimeter. Don't be surprised if you get some runoff from the no-till when you add "rain" at the rate of 60 inches per hour or so. Try to simulate natural conditions, and be prepared to answer questions.

8. Planting season is right around the corner.

Now is the time to get the word out, but be careful. Reduction in runoff is only one important factor when considering no-till.

Have a good stock of the Conservation Tillage Initiative brochures to hand out at any event. Try to point the producers towards individuals well versed in conservation tillage technology. Encourage the producers to have their fields inspected by an expert.

Years ago many individuals tried no-till and failed. This was because no-till is not just the absence of tilling. No-till is a management system.

Management systems take time to change, and soils that have been managed through conventional tillage may require special management practices like deep ripping and winter cover crops to break them out of the tillage cycle.

Once no-till is established, the nutrient management plan must take the need for a "nitrogen" boost in the spring to ensure that a nice big year is set.

In some cases, all you should do is plant the seed so that the producer can get the facts and assistance. That producer may have to wait till this fall to apply prescriptions to prepare the soil for no-till next spring. The goal is to help the producer maximize profit using no-till so that conventional tillage is no longer a consideration.

If you do not have brochures, try printing out some business cards with some Web links. Or better yet, if the producer has e-mail and access to the internet, mail him appropriate linksm such as the three listed below.

http://www.agry.purdue.edu/cti/

http://www.agry.purdue.edu/cti/aboutus/index.html

http://www.russellagriservice.com/Conservation_Tillage.html

Two excellent publications that I have become aware of in the last couple of years are:

Better Soils With the No-Till System

http://panutrientmgmt.cas.psu.edu/pdf/rp_better_soils_with_noTill.pdf

and

Steps Toward a Successful Transition to No-Till

http://www.ngdc.wvu.edu/~hferguson/educationNGDC/OM_videos/uc192.pdf

9. Key points:

To effectively communicate the no-till message, you will need some background information. Put yourself in the place of the producer and ask yourself, "What would it take to convince me to take a risk and change my management system?" Also, chances are there will be some environmentalists in your group, so ask yourself, "What would it take to make me, as an environmentalist, so sure that no-till is good for the environment that I would be willing to promote it?"

Realizing that technology and our understanding of no-till are always changing, some sources of Information for Indiana are:

Who is using no-till?

2004 Conservation Tillage Reports: Report the number of acres managed using no-till in 2004. (Corn and soybeans)

http://www.in.gov/dnr/soilcons/publications/transect.html

http://www.agry.purdue.edu/swq/images/tillage.pdf

General background for No-till Corn Following Soybeans:

http://www.ces.purdue.edu/extmedia/AY/AY-313.pdf

Will I lose money?

http://www.russellagriservice.com/Conservation_Tillage.html

Does no-till cost more for chemicals?

http://www.agry.purdue.edu/swq/images/maxprogram.pdf

What about all that residue? What good is it, and how can I manage it?

Do I need to change my fertilizer (nutrient management) plan?

http://www.agry.purdue.edu/ext/pubs/AY-280-W.pdf

What about the environment? (Depending upon your audience, there could be some controversial topics here. The BiotechPaper covers the advantages of herbicide-tolerant crops. It also discusses reduction of runoff...) I am still looking for papers that target the leaching issue. That is a tough one because there are so many variables concerning what is leached, whether it is more harmful than that which is leached from conventionally tilled fields. There also are vast regional differences in soil types, climate, whether the ground water is used for consumption, and what changes occur before the water enters surface sources. Some of the recipients may know of some good sources of information for this topic.

http://www.ctic.purdue.edu/CTIC/BiotechPaper.pdf

After using these models for a couple of years, I have made a couple of surprising observations.
1. Since I live in West Virginia, I went back to the Midwest to collect samples and I wrapped them in cellophane. Upon unwrapping them after a year and a half, I observed that there were still critters living in the moist soils. All of the residue had been eaten, and the surface of the soil was like coarse sand grains. (The silt loam soil was aggregated into a fine granular structure.)

2. I performed the slaking test on the "cultivated" samples after a year and a half of their being wrapped and observed that the soil clung together similarly to the no-tilled samples. Apparently a year and a half was enough for fungi to grow and start to bind the soil together.

3. I observed that I could create artificial macropores in the "no-tilled" samples and that they would not collapse while running the experiment. When small macropores (made with a piece of wire coat hanger) up to ¼ inch in diameter are made in conventionally tilled soils, I observed them fill and seal in a short time, demonstrating the weak nature of tilled soils. If you were to do this, you no longer have a truly undisturbed sample. If you ever have to do this because the natural macropores have collapsed due to the transport of the samples in a wet state, you should tell your audience. It is important for you to maintain your credibility as an educator.

I hope that you all enjoy experimenting and demonstrating with your mini-soil-lysimeters (infiltration/runoff models).