Making the Transition to No Tillage
By Jon Stika

Introduction

The first step in making a transition to farming without tillage is to change the way you think about soil. Soil is a biological system that must be managed with an understanding that the soil is habitat for an incredible number and diversity of organisms (aka the Soil Food Web). It is this multitude of organisms, both visible and microscopic, that builds and operates the soil. Farming without tillage provides an undisturbed soil that is ideal habitat for the Soil Food Web. The health and balance of the Soil Food Web drives the health of the soil and its’ ability to function. The two primary functions that growers depend on the soil to perform are to infiltrate and hold water for their crops and to feed their crops. Both of these functions are directly linked to the health and balance of the Soil Food Web. Farming without tillage, or “No Till” is an excellent tool to improve soil health. No Till is not a goal in itself, but a tool to build soil health.

How Do I Begin?

No Till does not begin with a drill or planter, it begins at harvest of the previous crop. The key to preparing a field for no tillage is uniformity. The previous crop residues (including chaff) must be spread uniformly at harvest. Most crop residues must be spread with the combine, as they are usually difficult (if not impossible) to distribute evenly, without disturbing the soil, after they have come in contact with the soil. A straw and chaff spreader on the combine should spread the crop residues evenly out to the width of harvest, or at least 75% of the width of harvest.

The next consideration is that of crop rotation diversity. Many no till systems fail due to the lack of crop rotation diversity. If you are not willing to diversify your crop rotation, your transition to no till will be a difficult and expensive endeavor. A rule of thumb is to have at least a two-year (or two-crop in warmer climates) break between each crop type of; cool season grass, cool season broadleaf, warm season grass or warm season broadleaf. Cover crops between cash crops can provide an excellent opportunity to increase crop rotation diversity.

Weed control is the next consideration in the transition to no tillage. Weed control in a no till system is accomplished through; crop rotation, no soil disturbance, residue cover, herbicide chemistry, sanitation, fertility and seeding rate.

Fertility of the soil must also be considered in a system without tillage. When the soil is no longer disturbed, the Soil Food Web changes and thus how the soil feeds the plants. In a no till system, you must focus on feeding the soil so the soil can feed the plants. The soil is best fed by living roots of a great diversity of plants, not by synthetic fertilizer. However, synthetic fertilizer and/or organic fertilizer (animal manure, etc.) are important tools for making the transition to no till.

The last primary consideration when transitioning to no till is the placement of seed in the soil with the least amount of soil disturbance. This is where specialized drills and planters are very helpful, if not essential. No till drills and planters have been perfected and available for many years now and used equipment is often available at much less cost than new equipment.

Residue Management

Crop residue management begins at harvest. The goal of crop residue management should be to distribute the residue as uniformly as possible directly with harvest equipment. The idea is to produce a consistent seedbed for the next crop. By doing so, the seedbed remains at the same temperature and moisture across the field for even planting conditions and crop emergence. In addition, weed seeds germinate and grow uniformly and are thus easier to control with herbicides.

The residue produced from the leaves, stems, and seed heads of each crop are different. Dark-colored residue warms more quickly in the spring allowing the soil to warm-up faster with it. Crops that produce a small amount of dark colored residue (such as peas, beans, or lentils) provide an excellent fast-warming seedbed for crops like corn or sunflowers. Crops that produce large amounts of light-colored residue
(such as wheat, barley, or oats) keep the soil cool and retain additional moisture.

By integrating a variety of crops into a rotation, a balance can be reached between moisture conservation and favorable seedbed conditions for successive crops in the rotation. A high residue crop such as wheat will produce a cool, high moisture seedbed for peas, which will produce a warm relatively moist seedbed for corn, which will leave a cool high moisture seedbed for wheat again.

The carbon to nitrogen ratio of the residue of each of these crops also varies greatly and promotes different populations of soil microbes that break the residues down. This diversity of both crops and soil life helps reduce disease and insect outbreaks by maintaining a balance of organisms in the soil. A good crop rotation also provides breaks between each type of crop so no one disease or insect can increase from one year to the next.

### Crop Rotation

Crop rotation is a major factor to the success or failure of a no till system. More specifically, crop rotation diversity. A diverse crop rotation means growing different types of crops in a sequence where each crop compliments the production of the others.

#### Types of crops

There are basically four different types of crops to make a diverse rotation; cool-season grasses (cereal grains), cool-season broadleaf’s (flax, canola, lentil, pea, lupine, etc.), warm-season grasses (corn, sorghum, millet, etc.), and warm-season broadleaf’s (sunflower, safflower, chickpea, beans, alfalfa, etc.).

To reap the benefits of diversity, crops need to be organized into a logical sequence that provides enough of a break between each crop type to prevent the symptoms of weeds, insects, and diseases we often see in a mono-culture of only one crop type.

**Diversify to spread risk and workload**

Bad weather at the wrong time for one crop can be good weather for another crop. A diverse crop rotation can spread the risk of weather and market fluctuations. It is also possible to plant more acres with smaller planting equipment if the crops being grown don’t all have to be planted at the same time. Cool-season crops are planted during one “window” of time and warm-season or fall seeded crops during other “windows” of time. Spreading workload can reduce the need for large equipment and labor throughout the year.

**Diversify to create proper conditions to plant and grow each crop**

The color and amount of residue determine planting and seedling emergence conditions for each crop, and moisture left from the previous crop. Dark colored residues warm-up faster in the spring, and heavy amounts of residue retain more soil moisture. Long-season crops use more soil water than short-season crops.

The potential yield for each crop can be maximized by arranging crops in a rotation that provide the best seeding and moisture conditions for each crop. The most moisture is conserved with the soil covered by a thick layer of light-colored, upright residue that traps snow during the winter. The time interval between the harvest of one crop and the water demand of the next crop will determine the potential for storing-up water in the soil.

**Diversify to aid in weed control**

When seeding a crop, the soil your drill disturbs also brings weed seed into a zone where it can germinate. Varying seeding dates, using different herbicides from year to year, and planting different types of crops will change the conditions that weeds will be subject to, and put them at a competitive disadvantage with the each crop. A drill or planter that disturbs as little soil as possible will minimize weed seed germination.

**Diversify to aid in disease control**

The majority of the diseases that lower crop yield or quality can be reduced significantly by implementing a diverse crop rotation. A cropping pattern that lacks diversity allows disease organisms to increase to levels that insure a high degree of infection when
conditions are right. A diverse crop rotation can reduce the population of disease-causing organisms so infection is rare and loss of yield or decline in crop quality is minimal. Given the crop losses to disease in recent years, the need for crop rotation diversity cannot be overstated.

Understanding crop rotation diversity can reduce or prevent many of the symptoms of weeds, diseases, and insects evident in a monoculture situation. Growing different types of crops in a sequence where each crop compliments the production of the others makes both ecologic and economic sense.

For details on how to develop a good diverse crop rotation, download a copy of “The Power Behind Crop Rotations” from the Dakota Lakes Research Farm in Pierre, SD at; http://www.abs.sdstate.edu/aes/dakotalakes/. For additional assistance in running the crop rotation diversity index, download a copy from http://www.ag.ndsu.nodak.edu/dickinson/agronomy/jons%20worksheet.htm

Weed Control

A diverse crop rotation can go a long way to reducing weed pressure. Planting different types of crops each year changes the conditions that weeds will be subject to. This puts weeds at a competitive disadvantage with each crop because the time of planting and growth of each crop will differ from that of the weeds that may have been a problem in a previous crop. A warm-season broadleaf weed will struggle to establish itself under the competition of an early growing cool-season grass crop.

A diverse rotation also makes it much easier to control weeds with herbicides. Killing grassy weeds in a broadleaf crop or killing broadleaf weeds in a grassy crop is usually more effective and less expensive than trying to kill weeds that are the same type of plant as the crop they have invaded.

Weed control through no soil disturbance

When seeding a crop, the soil your drill disturbs brings weed seed into a zone where it can germinate along with your crop. True no-till leaves weed seeds in place. The weed seeds that are deep in the soil do not germinate and eventually rot, and those that are shallow germinate and (hopefully) are controlled before producing more seed. That being said, a true no-till system will gradually require less use of herbicide as weed pressure decreases. A planting method that causes soil disturbance (either pre-plant tillage or one-pass seeding equipment that causes significant soil disturbance) will continue to plant weed seed along with the crop each year.

Weed control through soil cover

Obviously accumulated crop residue on the soil surface acts as mulch to prevent weeds from sprouting in the soil underneath. The less the residue cover is disturbed the better it can perform as a mulch. Selecting crops that produce enough residues to maintain effective mulch throughout the rotation is also important. Growing crops that produce different types and amounts of residue can assure that mulch is maintained on the soil surface as the residue decomposes and feeds the soil. Crop residue (including chaff) should be spread as evenly as possible across the soil surface during the harvest operation to create a uniform seedbed for planting the next crop.

Weed control through herbicide chemistry

Using different herbicides to control a particular type of weed from year to year will help prevent the eventual selection of herbicide resistant strains of weed(s). Just as crop rotation prevents the build-up of particular weed pressure, rotating herbicide chemistry prevents a build-up of herbicide resistant weeds.

Weed control through sanitation

Weeds can also invade a crop field from field margins, unclean equipment, or seed. Weeds that are not controlled along field margins can go to seed and fall into the cropped field or be cut by harvest equipment and spread with the chaff behind the combine. Weed seed can also travel along on farm equipment that is not cleaned-off from one field to the next and drop off anywhere into a different field. Bin-run seed can contain weed seed that will be planted along with the crop. Seed should always be cleaned of weed seed before planting.
Weed control through adequate fertility

It has been said that the best herbicide is a thick stand of healthy crop. Seeding to achieve an adequate plant population and providing it with sufficient fertility to compete with weeds and achieve the desired yield goal is the most economical approach to weed control. Weeds typically grow better than crop when fertility is lacking. Soil testing on a regular basis can provide the information necessary to properly fertilize each crop.

Weed control through adequate seeding rate

Plant to achieve a heavy stand of crop that can compete effectively with any weeds that germinate with the crop by planting only large, properly conditioned, clean, germination-tested seed. This may be the most cost-effective form of weed control a farmer can practice.

Successful weed control in no-till crop production is dependant upon: a diverse crop rotation, no soil disturbance, ample soil cover, diverse herbicide chemistry, attention to sanitation, adequate fertility, and a generous seeding rate. All of these aspects must be applied consistently to be successful in no-till crop production.

Seed Placement

Managing crop residue to conserve moisture, influence soil temperature, and provide for good seed-to-soil contact is essential to successful no-till crop production. A well thought-out crop rotation can set the stage to achieve the best seedbed for each succeeding crop.

Relying on rain to germinate a crop after seeding is often necessary in tilled seedbeds, but not with no-till planting methods. Undisturbed crop residue can conserve moisture near the soil surface in the zone where seed will be planted. Seeds are almost always planted at a shallower than average depth directly into moist soil where they germinate soon afterward, getting the crop off to a quick and consistent start.

Some warm-season crops like corn benefit from a seedbed that warms quickly in the spring. Planting into dark-colored residue and/or low residue conditions will promote soil warming and hasten crop emergence. If this is not the case, “residue managers” that brush crop residue off the soil surface (without significant soil disturbance) only where the seed will be placed can create a low residue situation in the row. In northern climates this can make a substantial difference in yields of warm-season crops.

In no-till, residue management begins at crop harvest. Crop residue must be evenly dispersed back over the area from which it was harvested. This creates an even seedbed for the next crop and insures that all of the seed will be placed at the same rate and depth so it can emerge quickly and evenly. Any weed seed that germinates with the crop will also appear in an even manner and provide a uniform target for herbicides.

Additionally, uniform crop residue distribution results in reliable residue penetration and seed placement by no-till planting equipment. If crop residues (particularly chaff) are not evenly spread onto the soil surface, seeding equipment may suffer depth control, seed placement (seed-soil contact), or opener blockage problems.

Carefully managed crop residues can provide a proper no-till seedbed for each crop in a rotation. Placement of crop residues on the soil surface is best achieved at harvest rather than attempting to distribute residue with tillage that can result in undesirable soil disturbance.

Fertility

Fertilizer applied to a field feeds the microscopic life (microbes) in the soil (the “bugs” eat first) which in turn feed the plants that grow there. In the early years of a no-till system, the number and variety of species of microbes that inhabit the soil shift in response to the new residue-soil interface present under no-till that did not exist under a tilled system of production. In a tilled production system crop residue is placed in the soil. In a no-till system, the residue (with the exception of roots) is placed on the soil.

Given this situation, one must allow the soil and its inhabitants to adjust to a new balance of residue decomposition and nutrient cycling. This usually requires an addition of
approximately 20% more nitrogen to the system for the first three to four years. Once a new balance is established, the supply of nitrogen needed to feed each crop will come from the soil organic matter itself. Thus, the amount of fertilizer nitrogen needed should decrease to at or below the original requirement before the switch to no-till.

With that understanding, we then need to look at the kind, amount, placement, and timing of fertilizer application to produce each crop.

An analysis of soil samples is a good starting point to determine the kind and amount of nutrients needed to produce a given yield of each crop. The yield goal must be considered carefully to account for the water-supplying capacity of a given soil. If soil water is limiting, crop yield will be limited by water and fertilizer should be adjusted accordingly. Armed with adequate soil-test information, the kind and amount of nutrients needed to produce a crop is pretty straightforward.

Placement and timing of crop nutrients is a function of the living part of the soil. Remembering the “bugs eat first” rule, fertilizer placed in the soil at a time when soil microbes are active will be consumed by the microbes first. Fertilizer placed in the soil when the microbes are not active (cold and/or dry) could be lost to leaching or volatilization before soil microbes become active again.

Nutrients placed in the soil are protected from volatilization and are immediately available to soil microbes with the least chance of loss. Seeding equipment with disk-opening fertilizer placement attachments can place the fertilizer where it will be available to soil microbes and limit access of the nutrients to newly germinating weeds.

Care must also be taken on sandy, low organic matter soils that have a limited capacity to hold onto nutrients once they are made available from soil microbes. In these situations the soil should be fed in smaller increments during the spring and summer so nutrients are held and released from the soil closer to the rate of use by the crop. In this way a large amount of free nutrients aren’t susceptible to leaching below the root zone and lost.

Armed with current soil test information and an understanding that the “bugs eat first” in the soil, fertilizer management becomes a fairly straightforward process. The economics of fertilizer management is simple; too little fertility or fertilizer applied at the wrong time results in low yields, too much fertilizer results in unused and often wasted nutrients (and money). Balancing the application of crop nutrients to meet crop needs within the limits of each soil will make the most sense, both economically and environmentally.

In Conclusion…

As you can see, a no-till system must be looked at as a whole, while paying attention to the details. When soil is no longer physically disturbed by tillage it will change. The soil will begin to function better than when it was tilled. If you change to no tillage, the soil will change and so must your thinking on how to manage the system without tillage in your agronomic toolbox. Be patient and allow the soil to recover (3 to 4 years) and achieve a new equilibrium and a higher level of function. There will be weed, fertility and moisture issues during this transition period that must be endured, but the soil will find a new balance in time. The benefits in time, labor, energy, reduced inputs will outweigh the risks in switching to no-till if you commit to the change and allow your soil to restore itself.

Additional Reading & Resources

Manitoba-North Dakota Zero Tillage Farmers’ Association Zero Tillage Production manuals at: http://www.mandakzerotill.org/archives.htm

No-Till on the Plains http://www.notill.org/

Conservation Technology Information Center http://www.conservationinformation.org/