No-till success hinges on developing a complete crop production "system"

by Donald Lobb

Our farm in Ontario is located near Lake Huron on about the same latitude as Saginaw, Michigan. The farm's soil ranges from a coarse sandy loam, which is underlain with 15 feet of gravel, to a fine silty clay loam with about 40-70% clay content. The topography varies from near level to rolling and hilly. We grow corn, soys and cereals for seed.

We have adopted a wide range of soil conservation practices, one of which is no-till. For the past fifteen years, we have studied the system and have learned a great deal from our own experiences and from the many researchers who have done work on our farm.

We have, of course, experienced significant savings in equipment costs, fuel, time and soil. And we have not increased costs for fertilizer or pesticides. In fact, the practices and products which we use today are safer environmentally than those commonly used in a tilled system.

Crop yields during our first six years of no-till corn were 5% higher for the no-till than conventional till on easy to manage soils. And the yields were the same on difficult to manage soil like: clay and silty loam. The soy yields were variable, but averaged slightly higher for no-till. While the cereal yields were consistently higher for no-till planted into soy residue, and variable depending on the variety when planted into corn residue.

We have maintained no-till/mouldboard research comparison sites for 15 years on sandy loam and silty clay loam (40-60% clay). Here, on the long established no-till sites, corn and soy yields have been 15% higher than mouldboard comparisons over the past eight years. On the clay comparisons, no-till has had an even greater advantage than on sandy loam soils six out of eight years. In the long term, the greatest advantage for no-till seems to be on our clay soils. Clay soils can be expected to have the greatest benefit from macropore development. Many long-term no-tillers have, more casually, observed similar findings.

So why are crop yield reductions usually associated with no-till?

If a comparison is attempted between no-till and some other tillage practices, the focus, too often, is strictly on tillage and does not include factors such as: weed control, variety selection, fertility programs, etc. Without some luck, failure for no-till is almost guaranteed because there is an interaction between tillage and almost all the other crop production factors. Each of the factors must compliment one another, and be fine-tuned into a no-till production "system" for it to be successful.

A no-till production system is the "art" side of crop production and successful farmers have done this best. The "science" side of crop production is when researchers compare individual crop variables -not an entire system.

The development of a good no-till production "system" demands that farmers make good use of both the "art" and "science" sides of crop production. Some current observations which should be considered when developing a no-till system are:

Tillage:

• Tillage plants weed seeds, destroys macropores (limiting drainage and aeration of the soil), and disrupts soil ecology which limits the natural nutrient release process.

• Enough tillage is required to get good seed and fertilizer placement.

• Tillage coulters or row cleaners should clear corn rows of crop residue when corn follows corn or cereals.

• In the short term, some tillage in the row area may enhance plant growth, but not necessarily yields. So yield checks are required.

Residue:

• Residue is inexpensively incorporated into the soil by earthworms.

• It may cause increased upper plant disease if appropriate crop rotation is not used.

• It may contribute to increased root disease by causing damp soil conditions, therefore appropriate variety selection is important.

• Residues contribute to cool, damp growing conditions and slug damage unless the row area is mechanically cleared.

• Corn chaff can be detrimental to the following crop if not sprayed evenly.

Crop rotation:

• Crop production breaks disease and insect cycles and enhances weed control.

• Legumes, when included in a rotation, contribute to increased earthworm populations.

• Continuous no-till corn on clay, and clay loam soil has historically caused a 10-30% yield reduction.

Cover crops:

• Cover crops can carry nutrients over a winter for the next crop.

• They are occasionally needed to protect very fragile soils.

• They add to production costs (seed/spray).

• They are a source of weed seeds.

• Legumes can increase nitrate contamination.

• The kill date for cover crops is critical and must be respected so that they do not cause the soil to be too wet or too dry at planting time, and that they do not enhance crop pest life cycles.

Weed control:

• Minimize the amount of tillage done because tillage plants weed seeds and brings old weed seeds to the soil surface where they can germinate.

• Apply fertilizer in row bands or side-dress. Apply it when the crop (not the weeks) need it.

• The type of weeds change with no-till so weed control strategy must change in time.

• The time of weed treatment is different with no-till.

• No-till weed control is more reliable because it is less weather dependent.

Insects/slugs:

• Slugs like residue for protection - clay soil, manure, green cover crops, moisture - therefore remove residue from the crop row to dry the soil and kill all pre-crop vegetation early.

• Insects - cut worms, army worms, etc. - have life cycles which are dependent on pre-crop vegetation, therefore kill all pre-crop vegetation early and use crop rotation.

Crop disease:

• Expect more upper plant and fewer root diseases, particularly with grass type crops. Soys should be selected more carefully because of increased root disease potential.

• The overall disease situation is not worse with no-till.

Variety selection:

• Always check variety within your crop production "system", because no-till crops are subjected to different soil conditions, disease pressure, herbicide programs, etc.

Drainage:

• Drainage must be good on all soil types and can be expected to improve as macropore development occurs.

• Planting may be delayed at first, however after several years it is often earlier than mouldboard plowed soil.

Fertility:

• For corn, apply 30-40 pounds of nitrogen at planting time - the balance as an injected side-dress application.

• Apply all potash in row bands incorporated into the soil.

• Nutrient stratification has not been shown to reduce crop yield with proper fertilizer application.

• Research has shown organic phosphate availability to be increased in no-till soil.

Soil ecology:

• Research has shown that the soil life (mycorrhizas) which release nutrients such as P, in particular, and N prefer no-till and will build a population quickly when the soil is undisturbed, - they are important in the nutrient release process. There may be a short time lapse when yields are reduced or extra nutrients are required.

• Macropore development, earth worm holes and old root channels will in time replace tillage in creating soil porosity.

• The benefits of soil ecology changes have not usually been accounted for in tillage research comparisons because most research is only funded for two to four years.

When all of the components of no-till crop production are brought into a "system", it can be easily seen that each is equally important and none can be treated or evaluated in isolation from the others.

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Components of a no-till crop production "system"

Cutline: The arrows point both inward and outward because each component affects the whole system and the whole system affects each component. Often a chain reaction, or combination of chain reactions, affects the set-up.

While changing tillage methods can be the first step in adopting a no-till crop production "system," tillage in itself does not affect crop yield more than any of several other production components. Disregarding the "system" of crop production components frequently explains why no-till in research, in demonstrations, and in farmers' fields fails. However, by focusing on all the "system" interactions will create a much higher probability of making a no-till crop production system successful and profitable.